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THE SUBMERGED FORESTS OF THE WIRRAL, IN CHESHIRE.

By HENRY O. FORBES, LL.D., F.R.G.S.

Director of Museums to the Corporation of Liverpool.

THE pedestrian proceeding along the Cheshire shore from the mouth of the Mersey to that of the Dee, will, when about half-way along, find his progress interrupted by the walls of the ancient castle of Leasowe, the residence till quite recently of the Cust family. It is an interesting structure and worthy of a visit, if for nothing else than the fine view over the Wirral—as the interesting country between the two rivers is termed—to be had from its tower. It is said to have been built by a Lord Derby in the reign of Elizabeth as a residence during his visits to the races annually held at Leasowe, when it was known as "Mock Beggars' Hall." Before it was dismantled of its contents a few months ago one of its chambers was panelled and roofed with fittings of the famous Star Chamber in Westminster Palace, purchased and brought here on its demolition. This interesting interior has, we believe, been transported back to London to the family's town residence.

On the walls of the staircase there hung, till the same recent period, equally interesting and much more ancient objects of interest. These were the almost perfect skull of the great primigenial ox (*Bos primigenius*), some fine antlers of the red deer (*Cervus elephas*), and bones of the short-horned ox (*Bos longifrons*). They were all dyed black from their long repose in the vegetable mould of the forest in which they roamed, over part of which the castle now stands. And who may dare to say that these same kine may not have sheltered under the very oak trees out of whose disentombed boles the black furniture of the library and seats in the hall were made?

All along the seaward front of the castle a strong shelving embankment of masonry, against which the sea washes at high tides, protects the site on which the castle stands from the action of the waves. On the top of this embankment our itinerant palæontologist may rest with pleasure on a fine day, and, while surveying the mercantile fleets that are ceaselessly passing in and out of the estuary of the Mersey, watch the thousand islands of sand and mud as they rise above the water with the receding tide, the results of erosion and redistribution which are modifying the coast-line.

Fifty years ago the sea was half a mile distant from the castle front, and no embankment was required, for a broad rampart of sand hills protected it. Since then the horizontal action of the sea has encroached far on the land, and to the eastward of the castle has removed long lines of this blown sand, and, but for its masonry embankment, that edifice must long ago also have been washed away. The observant traveller, sitting at very low tides on its south-west end and looking westwards along the coast, would see extended between the water's edge and the sandhills behind, a rough dark expanse of shore, stretching towards Hoylake village, which must arrest his attention and induce him to visit it. From the embankment he would walk along to Dove Point upon the sandhills, and descend from them upon a *bed of sandy peat*, protruding from beneath its æolian covering, whose edge, denudated by the sea, is about two feet in thickness. On the surface of this bed he may, if he be alert and fortunate, collect *Lymnæas* and other fresh-water shells, bones of deer, horse, and other recent animals, as well as articles of Norman, Saxon, and Roman manufacture, besides the flotsam and jetsam of the innumerable wrecks that since Roman times have been continually washed upon it. This *soil-bed* is evidently, he would perceive, the last surface of the land before it was covered by sand. His next descent would lead him upon a *bed of peat* underlying the soil-bed; and a foot lower he would find himself traversing a *clay bed*, through which, where it has been denuded, *another peaty surface* comes in view, with protruding stools, two to three feet in height, of thick forest trees—alder, willow, birch, elm, fir, and oak—whose roots still spread down into the soil in which they grew, their stems lying prostrate in all directions. There is no mistaking this for anything but a forest in ruins. Its denuded edge measures about three feet in height, and Fig. 1, from a photograph taken—as are all the others which illustrate this paper—by Mr. Charles A. Defieux, of Liverpool, affords an excellent idea of its appearance. Another downward step brings the investigator on a second layer of blue clay some thirty inches in depth, overlying the peaty *débris* of a *lower forest*, whose fallen stems recline by the side of their own still undisturbed stumps, whence the roots can be traced stretching down, as when they lived, unto yet a lower stratum of clay, in some places of red sand covering the clay, full of pebbles and boulders inscribed with striæ that tell their own story. This lower forest bed has, within the past thirty years, suffered much by marine denudation, and has quite vanished from many places where it used to be distinctly visible. In Fig. 1 its site would occupy the light triangular area in the centre of the right-hand side of the illustration.

Beneath the boulder clay are encountered no rocks

newer than the red marl of the Triassic, formed at the beginning of the Mesozoic Age. "After the deposition of the red marls," says Mr. G. Morton in his excellent geology of the country round Liverpool—to which the reader is referred for fuller information—"at the termination of the Triassic, there is a great blank in the geological history of the country round Liverpool. Whatever formations may have been deposited afterwards, no record of them now remains, for denuding agencies were in action, and not only swept them away," but ground down much also of the Trias, Permian, and Carboniferous strata. Fig. 2 exhibits a view of the denuded surface of the Triassic lower pebble beds in Middle Hilbre Island (lying in the entrance of the estuary of the Dee, and only a few miles from Dove Point), and the peculiar current-bedded strata of which these rocks are composed.

Upon this undulating country, which presented much the same surface contours as now—except that the hills were somewhat higher—there came to be laid down by the ice-foot in the fulness of time, all over the district, a thick blanket of clay studded with blocks, borne from the South of Scotland and the North of England on the submergence of the Wirral, to at least some hundred and fifty feet, during the latter part of the Glacial Epoch. Upon the re-elevation of the land at the close of that dreary period there grew up, by-and-by, the extensive forest whose remains form the

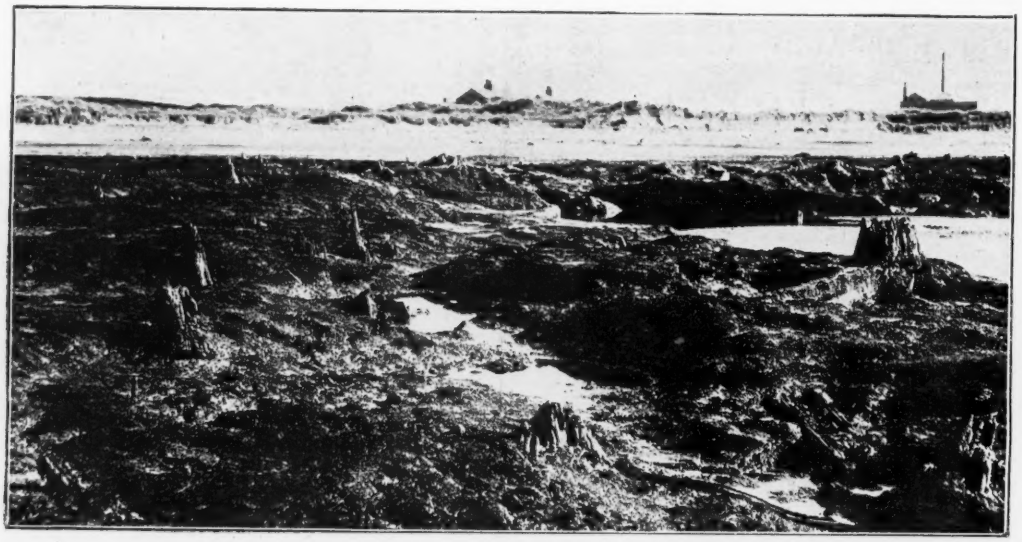

FIG. 1.—The Submerged Upper Forest Bed, near Dove Point, Cheshire, showing Stratification and Result of Wind-Erosion on Sandhills. From a photograph kindly supplied by Mr. Charles A. Defieux.

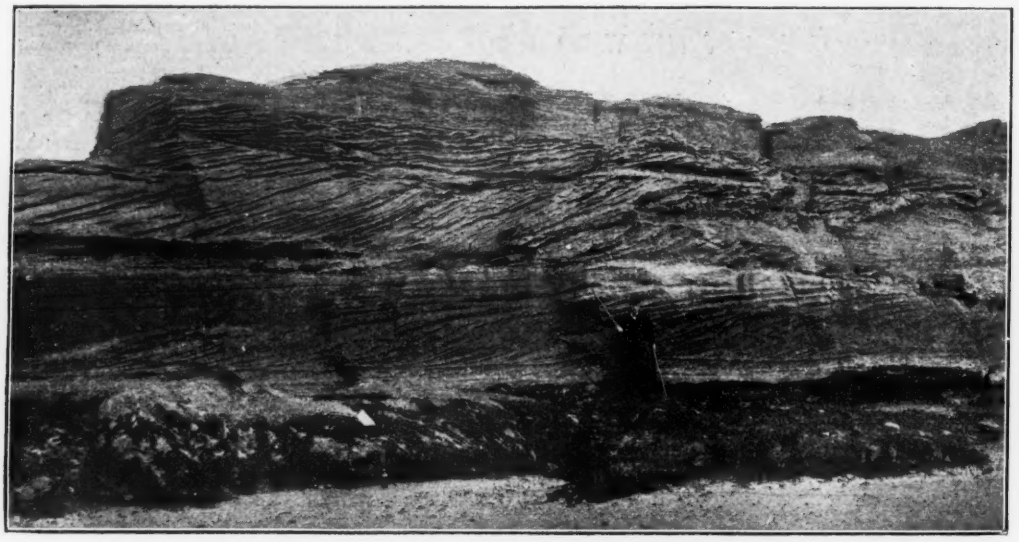

FIG. 2.—The Current-Bedded Strata of the Lower Pebble Beds, Middle Hilbre Island. From a photograph kindly supplied by Mr. Charles A. Defieux.

lower bed described above. Under its trees there harboured the wild boar, the wolf, the red deer, the urus, the short-horned ox, and perhaps the Arctic bear and the Irish elk. After flourishing for ages this forest, becoming water-logged through subsidence, was engulphed by an upgrowth of peat, and slowly perished as if by a malignant cancer. This peat bed being in turn buried over by sea-silt and laminated clay containing numerous marine shells, formed for a time, after its elevation, a hospitable surface for the seeds of various trees, and was in due time once more liveried with alder and elm, fir and oak trees, larger in size and more densely set together than in the lower forest, but sheltering a much diminished fauna. "There seems," says Morton, "to have been a successive growth of forest trees, until the drainage became intercepted and peat accumulated and formed the upper portion of the bed. It seems that the trees had gradually fallen, and that the most recent broke off near the ground in consequence of rotting in the wet peat surrounding them."

Borings, excavations for docks, and the sinking of wells in many parts of the district on both sides of the river have revealed the existence below the present surface of the ground of one or both of these buried forests. Beneath what was earlier in the century known as Wallasey Pool (now the great Birkenhead dock) the more ancient forest lies buried, and from it fine heads of the urus (*Bos primigenius*) and *Bos longifrons* (besides fragmentary human remains) have been recovered, probably from the very spots on which they died. Along the estuary of the Dee the lower peat and forest bed has been seen lying on the boulder clay. Along the northern coast from the mouth of the Alt River, near Formby, where remains of the urus and the Arctic bear have been found, and along the same side of the Mersey estuary, the younger forest bed has been identified. The extensive excavations for the Manchester Ship Canal traversed the same ancient forest. So that from the Alt to the Dee, and from an unknown distance seaward, then extending inland up the valleys of these rivers "as far as the Ince and Helsby marshes and the mouth of the River Weaver," the country was clothed with trees, which, after flourishing for ages, were gradually and slowly covered over—as at Dove Point, where our illustration, Fig. 2, is taken—by beds of blue and yellow marine silt as the shore continued to slowly subside. Upon this silt another band of peat accumulated through the stoppage of the natural drainage by subsidence, and over it again was laid down the remarkable peaty *soil-bed* above described.* Imbedded in the latter are the shells of fresh-water molluscs which formerly lived in its surface-pools, the remains of mammals—sheep, dog, and horse—not found in the older forests, and the Saxon and Roman antiquities already referred to. Most of these antiquities belong to the thirteenth century, and there are some who hold the opinion, according to Mr. Morton, "that some great flood or disaster occurred at the close of the fourteenth century, for very few articles have been found belonging to the period immediately succeeding it." It is remarkable that at the end of the thirteenth century there did take place a great invasion of the sea, which destroyed the Abbey of Stanlow, situated between Ellesmere Port and Ince. "I am fully convinced," says Mr. Mellard Reade, "that all the changes that have taken place since the Roman occupation have arisen from the *horizontal* encroachment of the sea and the erosion of the post-glacial land surfaces." Since then there has been neither elevation nor subsidence.

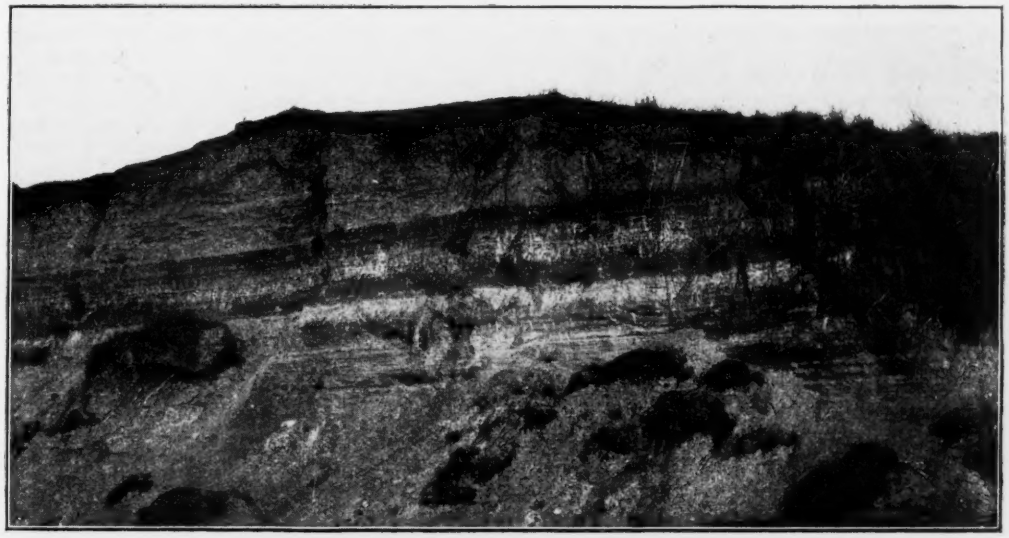

FIG. 3.—The Æolian Bedding of the Sandhills near Dove Point. From a photograph kindly supplied by Mr. Charles A. Defieux.

Topmost of all rests the blown sand, which in some places, especially to the north of the Mersey, forms dunes forty to one hundred feet in height and three miles in width along the shores of Lancashire and Cheshire. Fig. 3 gives a nearer view of a portion of one of these accumulations lying behind the forest bed seen in Fig. 1, to show its æolian stratification.

The lower peat and forest beds rest very often directly upon the boulder clay, or upon a *drift sand* re-formed out of it; and they date, therefore, from after the Ice Age. The fauna of that time appears to have been richer in

* For an account of the formation of peat mosses the reader is referred to a very interesting series of articles by Sir Edward Fry, on "British Mosses," in KNOWLEDGE, December 1st, 1891, and subsequent numbers.

numbers and more important in species when compared with that which inhabited the Wirral when the trees of the upper forest bed were flourishing, or roamed over it in later days to the present time. It was, however, vastly poorer in species, and these altogether meaner, when considered beside the grand Ungulates and imposing Carnivora that animated the district in pre-glacial times, and whose bones have been preserved in the caves of North Wales. Mr. Morton, who gives a list of the species whose bones have been found in caves sealed up beneath undisturbed beds of boulder clay, enumerates the cave lion, the spotted hyæna, the Arctic bear, the badger, the wild cat, the Irish elk, the reindeer, the wild boar, the woolly rhinoceros, the mammoth, the elephant, and the hippopotamus. On the threshold of one of these caves, and beneath the boulder clay, a flint flake found purposely fashioned proves that man shared the country, and, no doubt, contested possession of these rock shelters with some of the remarkable fauna which Britain could then boast of, and which has vanished for ever through, among other influences, the increase of population and the revolutionary march of the ploughshare.

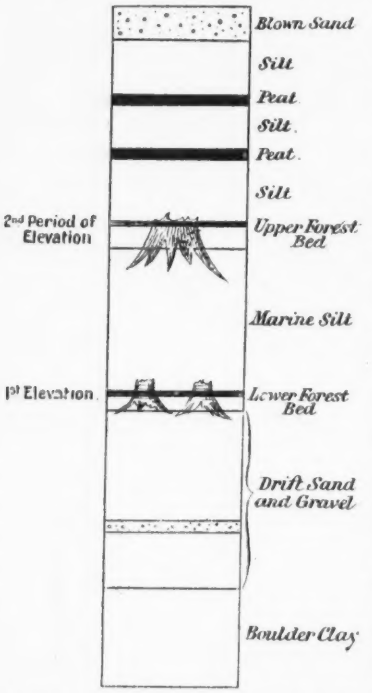

FIG. 4.—Section of the Strata over and under the Forest Beds.

ALUMINIUM: ITS HISTORY, MANUFACTURE, AND FUTURE.—II.

By SAMUEL RIDEAL, D.Sc.Lond., F.I.C.

AT the present time it may be said that all the aluminium brought into the market is the product of three factories, viz, the Pittsburgh Reduction Company of Pittsburgh and Niagara, the Aluminium Industrie Actien Gesellschaft of Neuhausen on the Rhine, and the Société Electrometallurgique Française of Froges in France. The aluminium company which has been at work in England for some years past has found that the chemical process used by them and devised by Mr. Castner cannot compete successfully with the newer companies, all of which manufacture aluminium by electrolytic processes. Quite recently a new company, under the name of the British Aluminium Company, has been formed in this country with the object of manufacturing the metal by an electrolytic process, and considerable progress has already been made by them.

These various electrolytic processes differ only very slightly, and depend for their success chiefly on the economic production of electrical energy. In America the Falls of Niagara, in Switzerland the Schafhausen Rhine Fall, are utilised, whilst the British Aluminium Company have acquired the water rights of the Falls of Foyers in Scotland. Although the cheap production of electrical energy has thus hastened the development of these large industrial undertakings, it must not be forgotten that about the year 1887 Chas. M. Hall, in America, by his discovery that alumina would dissolve in a molten bath of cryolite and fluorspar, rendered its utilisation in this particular industry feasible. He found that from such a bath a sufficiently strong current of electricity caused all the impurities to separate, and pure aluminium from the dissolved alumina was liberated at the negative electrode. The melted fluorides remain undecomposed if due precautions are observed, so that it becomes possible by feeding the bath with alumina to obtain a continuous separation of aluminium. The electrolysis of the alumina is brought about when the electromotive force is equivalent to 2·4 volts, whilst upwards of four volts are required for the decomposition of the fluorides. The composition of the flux is so adjusted by the third patent of Hall that it has, when molten, a specific gravity which is slightly lower than that of the metal, so that the latter, as soon as it is liberated, falls through the molten mass to the bottom of the electrolytic cell, and is thus prevented from being in contact with the air and so being altered by oxidation.

The Hall process is the one adopted by the Pittsburgh Reduction Company. In order to obtain the pure alumina for the electrolytic bath, native beauxite has to undergo a preliminary treatment. This consists in igniting it gently with soda ash, and in this way producing sodium aluminate, which is next treated with sufficient hot water to just dissolve it. Oxides of iron, silica, and other impurities remain undissolved, and the clear decanted solution of the aluminate is then decomposed by carbonic acid gas, obtained by the combustion of coke. The precipitated hydrated alumina is thus obtained pure, and on drying is ready for the bath, whilst the carbonate of soda simultaneously formed is available for a fresh portion of beauxite. The vessels in which the electrolysis is effected consist of iron pots lined with powdered carbon, and are connected with the negative terminal from the dynamo. To the bath of molten fluorides about one-third of their weight of alumina is added. The positive electrodes consist of blocks of compact carbon dipping into the molten mass, and, as already mentioned, the current used is of comparatively low voltage, so as to prevent the decomposition of the fluorides. Each machine produces at Niagara a direct current of two thousand five hundred ampères at one hundred and fifteen volts, and is obtained by transformers from a two thousand five hundred volt alternating current. The amount of energy required to produce one pound of aluminium is about five horse-power hours. The aluminium is liberated in globules which sink to the bottom of each of the iron pots, and there collect into a large molten "button." The first portions, being impure, are removed; the remainder is drawn off at intervals by a syphon, without interruption of the current. Alumina is added from time to time as the decomposition proceeds, so that the process is practically a continuous one. Chloride of calcium is occasionally added to render the bath more mobile and to prevent clogging. During the process the positive carbon electrode is oxidized to carbonic oxide, and has to be renewed from time to time. Theoretically, thirty-six parts by weight of carbon are required to produce fifty-four parts of metallic aluminium—thus:—

$$Al_2O_3 + 3C = Al_2 + 3CO;$$

but, practically, one pound of carbon is consumed per pound of aluminium formed, and this quantity is obtained per hour from each pot. The pots themselves and their linings last for months of continuous work. Unlike many industrial processes, there are no bye-products or slag, and there is no volatilization of the metal. The Pittsburgh works are only about half a mile from the Niagara Falls, so that the current is obtained directly from the mains of the Niagara Falls Power Company. This current is alternating, but it is converted into a direct one and its voltage is lowered by transformers at the works. The aluminium produced in America is of high comparative purity, the average percentage of the metal being ninety-nine and upwards. The chief impurities are silicon and iron, and its commercial value is now about thirty-five cents per pound.

In Switzerland and France the process adopted is that which was patented by P. L. V. Hèroult. As to the priority of these patents, it is interesting to note that the cryolite process was first proposed by Henderson, an Englishman, in 1886, but he never put his process into practice. The Hèroult process, as will be seen from the following description, is based on exactly the same principle as that involved in the patents taken out by Hall, although both these inventors worked independently of one another, and about the same time applied for the American patents; but on investigation it was found that Hall had produced the first aluminium on February 23rd, 1886, whereas Hèroult named only the date of his French patent of April 23rd, 1886.

Hèroult's first French patent deals with the production of pure aluminium. He places a mixture of alumina and cryolite in a carbon crucible surrounded by a larger one, the space between the two being filled with graphite. The positive electrode consists of a thick carbon rod which dips into the molten mass. A current of three volts is used by this inventor, but in other respects the process is similar to that of Hall.

By slight alterations in the working of the process it can be made available for the production of aluminium alloys. This consists in using a negative electrode of the metal—say copper—with which it is wished to form an alloy, when, as the current passes, the aluminium alloy is regularly formed, and collects as a melted button at the bottom of the crucible. It would seem that Hèroult hardly realized the importance of his invention towards cheapening the production of pure aluminium, as at this time he gave his chief attention to his alloy patent. This was acquired by the Société Metallurgique Suisse, at Neuhausen, and proved so satisfactory that the firm at once decided to use it for the manufacture of aluminium bronze on a very large scale.

The usual bronze contains forty-two per cent. of aluminium, and from it, by the addition of copper, alloys of different grades are produced in ordinary smelting furnaces. In 1888 the Société Electrometallurgique Suisse was converted into the present Aluminium Industrie Actien Gesellschaft, and the bronze plant was then augmented so as to yield one thousand kilos of bronze daily. Encouraged by the success of Hall's process in America, Hèroult, in conjunction with Kiliani, returned to his original process for the production of the pure metal, and soon succeeded in so improving his process that the Neuhausen company were enabled to erect additional plant, which already turns out five thousand five hundred pounds of commercially pure aluminium daily, and the new process has now almost entirely superseded the alloy process. In 1888 the Société Electrometallurgique Française, at Froges, acquired the right to use the Hèroult patents, and has since had a daily output of three thousand kilos of alloy, and has produced some fifty thousand kilos of pure aluminium per annum.

The British Aluminium Company, to which reference has been made, has only been in existence a short time, but has already erected plant at Larne for the treatment of their deposits of Irish beauxite, and are engaged upon the erection of reduction works at the Falls of Foyers and of metallurgical workshops at Milton. It is difficult, however, to predict the direction in which this English industry will develop, as at present no information has been published as to which electrolytic processes are to be employed. The statement of the chairman of the company that "the natural advantages of the Strath were even greater than those of Niagara, for the fall of water to Loch Ness was very much greater," remains to be proved.

Sufficient has been said to show that since the Paris Exhibition of 1855 the progress in this particular industry has been enormous, but a few statistics as to the total output may not be out of place.

According to Richards, the world's production up to 1892 was only two million five hundred and eighty-six thousand pounds; but in 1893 one million four hundred and seventy-four thousand pounds were produced, and in 1894 two million two hundred and forty-four thousand pounds. Last year the American output has been estimated at eight hundred and fifty thousand pounds, and it is believed that the production of the present year will reach over two million pounds, as the Pittsburgh Reduction Company will have ready by the 1st of June plant capable of making ten thousand pounds per day.

This increase has been accompanied by a reduction in the price, so that from being, as at one time, a luxury, and used as a cradle for the Prince Imperial of France and as a helmet for the Crown Prince of Denmark, aluminium can now be found in most houses. Amongst the many uses to which it is at present applied may be mentioned the following: military equipments, as water-bottles, spurs, sword handles, helmets, and horseshoes; naval purposes, torpedo-boats and yachts being made of it for lightness; bicycles; vehicles, autocars, etc. (an aluminium cab is running in Paris); aërial machines; besides numerous smaller articles of domestic use, and especially surgical and scientific apparatus. It will be seen that all these different uses indicate a great future for the metal, especially as, of the more common metals, iron, zinc, nickel, and copper are at present the only ones which are cheaper than aluminium.

SOME CURIOUS FACTS IN PLANT DISTRIBUTION.—III.

By W. BOTTING HEMSLEY, F.R.S.

STILL continuing on insular floras, I would say something about the Tristan d'Acunha group in the South Atlantic, in latitude 37°, and longitude 12° W.; and St. Paul and Amsterdam Islands, in the Indian Ocean, in almost exactly the same latitude as Tristan d'Acunha, and about 77° 30′ E. longitude, or in round numbers five thousand miles distant, with no land intervening in the same latitude. The history of botanical discovery in these islands is so intensely interesting that one is tempted to dwell on it; but I must be content to give the reader a taste only. The Tristan d'Acunha group consists of three islands only a few square miles in extent, yet one of them towers to the height of eight thousand feet. The main island has had a small population for some years. Amsterdam Island is larger—some six miles across—but rises only to a height of two thousand seven hundred and sixty feet. St. Paul is smaller, and less than eight hundred and fifty feet high.

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Both are uninhabited. Sir George Stanton, a member of Lord Macartney's embassy to China, was probably the first Englishman who brought dried plants from these two groups of islands. This was a century ago. For what is known of the vegetation of the smaller islands of the Tristan d'Acunha group we are wholly indebted to the late Prof. Moseley, of the *Challenger* expedition.

These islands support a much more luxuriant vegetation than those in higher latitudes to which I have referred; but here, as there, it is composed of few species, thirty-eight being the total in Amsterdam and St. Paul Islands, half ferns and lycopods and half flowering plants, and fifty-five in the Tristan d'Acunha group, whereof twenty-nine are flowering plants and twenty-six ferns and lycopods. The composition of the floras of these islands is exceedingly curious, for although the majority of the endemic species belong to genera that may be termed cosmopolitan, the bulk of the vegetation of these two groups of islands, five thousand miles apart, consists of *Phylica nitida* (Rhamnaceæ), a shrub or small tree, and a reed-grass, *Spartina arundinacea*. The latter is closely allied to a South American species, but hitherto it has only been found in these islands. In stature it is very different from our British species, which, I may add, is a widely spread seaside plant, not only in Europe, but recurring in North America and South Africa, the nearest land to Tristan d'Acunha. Inaccessible and Nightingale, the smaller uninhabited islands of the Tristan group, are almost covered with *Spartina arundinacea*, relieved here and there by clumps of the *Phylica*. This reed grows five to six feet high, and in such dense masses as to be impenetrable, except in the tracks made by penguins, prodigiously numerous colonies of which it shelters. It is equally abundant and luxuriant, in some parts, at least, of Amsterdam Island. In St. Paul it occurs in scattered clumps only.

The genus *Phylica* is allied to the buckthorns, and is represented in South Africa by upwards of thirty species; in the Island of St. Helena by one endemic species; by one or two in Madagascar; and by *P. nitida* in Tristan d'Acunha and Amsterdam I., which also inhabits the mountains of Bourbon and Mauritius. It is the only woody plant in the former islands bigger than the common crowberry, and it forms woods in the main island of the Tristan d'Acunha group and in Amsterdam, though it does not exist in the fifty miles distant St. Paul. I have mentioned the crowberry (*Empetrum nigrum*) because this British shrub, which is diffused all round the temperate and cold zones of the northern hemisphere, is represented in the extreme south of America, in the Falklands, and in Tristan d'Acunha, and nowhere else in the world, by a variety scarcely differing from the northern plant except in having red instead of black berries. Several other peculiarities in these remote insular floras offer problems in the distribution of plants not easy of solution; but some remarks I have to make on this point must be deferred. More than a third of the flowering plants and ferns of the two groups of islands under consideration are endemic. Of the remainder, some, especially the ferns, are of wide range; others are common to the New Zealand and the South American regions, as well as the intermediate islands whose vegetation I have already described; others, again, are partly common to the South American region and the islands, partly to the New Zealand region and the islands—*Pelargonium australe*, for instance.

The question how these and other remote islands became more or less clothed with vegetation is a most interesting one, and one that has been discussed and answered in a variety of ways. Few persons believe in a special creation, but the existing vegetation may be the remains of a former more extensive flora, and the islands themselves remains of a former continent; or it may have been derived from other countries, conveyed by birds, oceanic currents, and other agencies, and the islands themselves may be comparatively recent upheavals of the ocean bed.

In KNOWLEDGE for December, 1895, is an illustrated account of the appalling and disastrous eruption which desolated the Island of Krakatoa and neighbouring countries in 1883. The island was torn and rent, and what was left of it was covered with a layer of cinders and pumice stone from one to sixty mètres in thickness, which was, of course, at first of such intense heat as to utterly destroy all animal and vegetable life. A spot of such absorbing interest has naturally attracted the attention of all who have passed within view of it, and it was actually visited by a botanist (Dr. Treub) three years after the great eruption. His observations teach us how an absolutely barren island may become covered with vegetation.

The island, as the destructive forces left it, is about three miles across, and has an altitude of two thousand five hundred feet. One side presents an almost perpendicular wall to the sea, and the other side slopes steeply to the shore. Its situation in the Sunda Straits is twenty miles from Sumatra and twenty-one from Java; and the nearest point where there was terrestrial vegetation is the Island of Sibesie, ten miles distant. When Dr. Treub visited the island in 1886 he found the elements of a new flora, which he studied on the spot, afterwards publishing the results in detail.

The beginning of this new flora is the most instructive phase to study. Cinders and pumice stone do not suggest fertility; but it is astonishing what moisture and chemical action will do, and how one class of plants prepares the matrix for others of higher organization. On this unpromising medium the spores of filamentous algæ (chiefly species of the universally dispersed genus *Lyngbya*), carried thither by the winds, were the first to germinate, causing in their development a certain amount of disintegration. Individually these organisms are microscopic, but they multiply prodigiously, and form a green, film-like, gelatinous tissue over the surface on which they grow. The action of these organisms on the volcanic stratum, and their own decay, formed a medium in which the spores of ferns, brought by the currents of air, germinated and developed into plants. In this early stage of the new vegetation of Krakatoa, Dr. Treub observed eleven species of ferns, and some of them were already common. In their turn the ferns prepared the soil for plants of a still more complex organization, namely, flowering plants belonging to various families. At the time of Dr. Treub's visit plants of this class were quite rare, though fifteen species had already established themselves. These consisted partly of seaside plants, whose seeds were undoubtedly floated to the island and were cast ashore by the waves, and partly of plants whose seeds were either dropped by birds or carried thither by winds. Eight species were found on the mountainous interior of the island. Those on the seashore were all plants that have a very wide range in similar situations in the tropics, and are among those which first take possession of coral islands. The seeds of most of them have been proved by actual experiment to bear immersion or "flotation" for a long period in salt water without losing their vitality. Last year Dr. Treub visited Europe, and on his homeward voyage passed within view of the island, which, as he informed the writer, was then again covered with vegetation. This is a most instructive lesson in the natural distribution of plants, on account of its being the

result of actual observation. There are records of seeds being conveyed very much longer distances by oceanic currents and afterwards germinating; but here we have an instance of the complete renewal of a flora. In addition to plants growing on the seashore, Dr. Treub collected seeds or fruits of seven other species of flowering plants, including those of a screw-pine and the coconut.

The preponderance of ferns in remote volcanic islands is characteristic. In Ascension, for example, there is a dozen species of ferns and three of lycopods, against less than half a dozen certainly indigenous species of flowering plants; and the latter are comparatively rare. It should be remembered that in all these comparisons plants introduced by human agency are left out of consideration. The aboriginal flora of St. Helena comprised, so far as is known (some being now extinct), thirty-eight species of flowering plants and twenty-seven species of ferns and lycopods. In the Tristan d'Acunha group the numbers are twenty-nine and twenty-six respectively. In the small flora of Juan Fernandez there are forty-four species of ferns. The relatively large Bourbon Island, near Mauritius, has two hundred species of ferns, as against eight hundred species of flowering plants. The large proportion of ferns is easily accounted for by the fact that there is probably no limit to the distance fern spores are carried by the wind, and they are produced in such prodigious quantities that they are likely to reach the smallest and most remote islets.

I do not like to encumber an article of this description with too many botanical names, but so many persons know ferns that I feel justified in giving the names of those which had established themselves in Krakatoa three years after the great catastrophe. They are:—*Gymnogramme calomelanos*, *Acrostichum scandens*, *Blechnum orientale*, *Acrostichum aureum*, *Pteris longifolia*, *P. aquilina*, *P. marginata*, *Nephrolepis exaltata*, *Nephrodium calcaratum*, *N. flaccidum*, and *Onychium auratum*. These ferns are nearly all of wide distribution, and nearly all in cultivation. It will be seen, too, that the common bracken (*Pteris aquilina*), one of the most widely diffused ferns, is among them.

GREEK VASES.—III.

B.—BLACK-FIGURED VASES.

By H. B. WALTERS, M.A., F.S.A.

IN resuming the history of Greek vase painting, we have now to trace the course of development in a town that always played an important part in the history of the minor arts in Greece, and, consistently with its position as second only to Athens in commercial importance, may be regarded as second only to that city in the reputation of its fictile products. We refer to Corinth, which, from its geographical situation, was well suited to be one of the principal centres of Greek trade, while yet another circumstance contributed to its success in this particular branch. The soil of the surrounding country is composed of a whitish clay of peculiar excellence, which was employed not only for home products, but also to a great extent for exportation. Even Athens, favoured as it was in the possession of excellent clay in its immediate neighbourhood, sometimes made use of that of Corinth.

The first indication we have in Greek literature of a school of art at Corinth is in the account of the chest of Kypselos, which was set up by the family of that tyrant in the temple of Hera at Olympia about 600-580 B.C. From the minute description of this wonderful work of art given by the traveller Pausanias, we may gather that the carvings on the sides of this chest were very similar in style and range of subject to those on many existing Corinthian vases. At the same time the chest of Kypselos, regarded in the light of the evidence from vase paintings, must belong to a very highly developed stage of Corinthian art, and it will now be necessary to trace the preliminary steps which led up to it.

There is a small class of vases, mostly found at Corinth, of which the British Museum possesses the most notable example, all of diminutive size, but characterized by an extraordinary delicacy of execution. These vases are generally regarded as the earliest products of Corinthian ceramic art, and are known as Proto-Corinthian. The subjects which occur on them are of a comparatively simple nature—battle scenes, hunting scenes, and figures of animals, executed with marvellous minuteness. The shapes and method of decoration of these vases point to the influence of Oriental metal-work—an influence which made itself most strongly felt in the art products of Chalcis, in Eubœa; it has therefore been supposed that this group of vases belong rather to Chalcidian than Corinthian art, as there was undoubtedly a close connection between the two places. They appear to date from the seventh century B.C.

We must now, however, turn to the large number of vases the Corinthian origin of which is free from all doubt. It is true that examples are found in great quantities not only at Corinth, but in Bœotia, Rhodes, Italy, and other points of Greek civilization; but even if made on the spot where they have been found, the connection with those from Corinth is far too close to allow of any supposition other than that they are the work of Corinthian artists residing in that place.

In the earlier Corinthian vases Orientalism reaches its zenith. The surface is usually so crowded with rosettes and similar ornaments that the ground-colour almost disappears, and the general effect to the eye, both in colour and design, is that of rich Oriental embroidery. Fantastic monsters seem to have been directly chosen for their fitness to fill in spaces (as we see in some of the early sculptures found on the Acropolis at Athens). The ground is a clear yellow, varying in tone from cream to orange, on which the figures are painted in black with a purple pigment added for details; while a great fondness for incised lines is also noticeable. It is necessary to call attention to these two points, because they form a most salient feature of the black-figured vases.

In the repertoire of subjects we see a steady development, from the simple vegetable ornament to the elaborated scene from mythology. The steps are as follows: (1) vegetable ornament; (2) single animals; (3) animals in friezes, or heraldically grouped; (4) single human figures; (5) friezes or groups of human figures; (6) scenes of hunting or battles; (7) scenes from Greek mythology, or connected with the worship of Dionysos. Among the animals the lion is a principal favourite, and fantastic monsters are very popular, especially the Sphinx, Siren, and winged fish-tailed deities. We now first find names inscribed over the figures, and this is a matter of special importance as regards Corinthian vases, owing to the peculiarity of the alphabet employed, and the fact that the use of certain letters or forms of letters enables us to date many vases with tolerable certainty. These inscriptions range from about 650 to 500 B.C.

Before the growing sense that human action is the most appropriate subject for the vase painter, Orientalism begins to give way; the animal shapes, it is true, still encumber the field, but are for the most part restricted to

friezes bordering the design, of which they thereby gradually cease to become an integral part. The face is now generally rendered in silhouette, sometimes in outline, and the practice grows up of distinguishing female figures by the application of white for flesh tints; this afterwards became universal as long as the black-figure period lasted.

Another feature with which we now meet almost for the first time is that of artists' signatures; two are known to us on Corinthian vases, one of which is found on a specimen of a remarkable series of painted plaques discovered on the Acropolis of Corinth in 1879. Most of them bear dedications to Poseidon, and many also have representations of this god with his consort Amphitritè. On several specimens are representations of mining, of the potter's art, and other occupations of daily life. The inscriptions are important as dating these plaques between 650 and 550 B.C. They were hung up as votive tablets in a temple of Poseidon, the guardian deity of Corinth, and had been collected in a rubbish-heap like the Naucratis fragments mentioned in the last article.*

The favourite shapes of Corinthian potters are, in the earlier examples, the aryballos and alabastos, kylix, pyxis, black, on a thick, creamy slip, with purple and incised details. From a technical point of view they represent the same stage as the older Corinthian fabrics, but the drawing shows a great advance, while the mythological repertoire is comparatively large. They are generally attributed to the first half of the sixth century. One of the most remarkable specimens is in the Library at Paris, and represents Arkesilaos II., King of Cyrene on the north coast of Africa (580-550 B.C.), weighing out bales of the plant silphium (asafœtida). This plant was a product of the country, and a great source of revenue to the kings of Cyrene; it is represented on many of the coins. Another example in the British Museum (unfortunately, much injured) represents a female figure holding branches of silphium, surrounded by flying male and female figures. It has been most ingeniously shown that this figure represents the Hesperid nymph Cyrene, while the other figures are the Boreades (who bring the fertilizing north wind) and the Harpies (who guarded the Garden of the Hesperides). All this is very strong evidence for the presumption that these vases were manufactured at Cyrene, although it is true that none have been found there; there is also a

FIG. 1.—(*a*) Cup (Kylix) of so-called Cyrene Fabric, representing a Sacrifice; one-fourth original. (*b*) Cup (Cotyle) from Corinth; two Sirens confronted; one-fourth original. (*c*) Plate (Pinax); Warrior blowing Trumpet; one-fourth original.

and cotyle (Fig. 1*b*)—viz., small oil flasks and two-handled cups; but in the later stages the larger shapes, such as the amphora, crater, and hydria, come into general use; also the oinochoë. The later specimens are usually made of red clay, and are, in fact, little distinguishable from the earlier Athenian examples. It is an open question whether the Athenian vases were influenced by Corinthian, or the reverse; but, probably, both views contain a measure of truth. A wider field is now opened to the subjects, which include scenes from the Trojan legends or the exploits of Herakles. Names from mythology are frequently inscribed over the figures of banqueters, warriors, or huntsmen, or ordinary scenes from daily life, in order to intensify the interest or to give a sort of idealized picture of everyday events.

We must now retrace our steps once more to discuss a fabric of especial interest and importance, though represented by comparatively few specimens (see Fig. 1*a*). These vases are, almost without exception, of the shape known as *kylix*, or goblet, and the designs are painted, in lustrous close connection in technique with Naucratis, where, indeed, the last-mentioned vase was found.

We must now turn our attention once more to Athens, a city that is destined not only to supplant Corinth as the chief centre of ceramic art, but gradually to oust all other fabrics from favour or absorb their excellencies in its own, and to retain this monopoly unquestioned for two centuries. The impetus to this productiveness was given by the extraordinary advance of art and culture under the beneficent rule of the tyrant Peisistratos and his successors (565-510 B.C.). The immediate result of this development was to attract artists from all parts of Greece, and in the Athenian sculpture and vases of this period we are able to trace a marked influence of Peloponnesian art.

The museum at Florence possesses one of the most remarkable existing specimens of Greek pottery in the shape of a large vase (of the shape known as crater) found near Chiusi in 1844 by M. François, from whom it is always known as the François Vase. This vase bears the signature of two Athenian artists, to this effect: "Ergotimos made me, Klitias painted me"; and it is usually attributed to the middle of the sixth century. The

* *See* KNOWLEDGE for April.

alphabet in which the inscriptions are written clearly shows its Athenian origin, but there are several characteristics which betray Corinthian influence.

The British Museum and that at Berlin possess two similar vases, but of inferior size and merit, the principal subject on each being the birth of Athena from the head of Zeus. This was originally a Peloponnesian legend, and it is interesting to note that one of the figures on the Berlin vase is inscribed, "I am Hermes of Kyllene," referring to a mountain in Arcadia on which that god was especially worshipped. Further, the word Kyllene is spelt with an initial "Q," a letter which only occurs twice in Attic inscriptions, but is common in Peloponnesian alphabets.

From this time onwards the history of Athenian vase painting is one of continuous and rapid development. One noteworthy result of this development is in the shapes employed, which in the earlier periods show an extraordinary variety. But the shapes in common use by Athenian potters may be limited to perhaps a dozen or so, and of these only five may be said to enjoy anything like popularity. These are the amphora (by far the most popular of all), the hydria (three-handled pitcher), oinochoë (wine jug), lekythos (oil flask), and kylix (goblet). Several of these shapes pass through successive phases of development which are of great assistance in a chronological classification. We may take the amphora and kylix as best illustrating our purpose. The earlier examples of the amphora are obviously Corinthian in type, and have a thick body, more or less egg-shaped, running up without marked division into the neck, and thick cylindrical handles. The whole vase is covered with black varnish, except a panel on either side in which is the design. Another variety is chiefly represented by the Panathenaic amphoræ, which we shall discuss later, which have a very short neck and converge below to a very small foot. The later examples have a high cylindrical neck strongly set-off from the body, which has a high flat shoulder. In these the black varnish is only applied on the mouth, foot, and handles (which are formed of three parallel ribs), the whole of the vase being left red, except for the figures, and highly glazed. The early kylix has a high stem, and the upper part of the bowl is set at an angle to the lower, forming a band for the designs; in the next stage this angle becomes more obtuse, and the band is narrowed by a broad stripe of black varnish round the lip; finally the angle is replaced by a continuous outward curve, and the foot becomes shorter and thicker.

The technique of the black-figured vases is marked by two notable features, the first being the red clay of which the vases were manufactured, which was found in such abundance in the plains of Attica; its hue is due to an oxide of iron. This red clay is admirably suited for taking a glaze—an essential preliminary to the process of painting on such a material. The second feature is the black, varnish-like pigment which was used, not only for filling in the contours of the figures and for the decorative patterns, but also for covering the mouth, foot, and handles.

Two accessory colours are employed, purple and white; the latter mostly for the flesh of women, for the hair of old men, or for the long garment worn by the charioteer. It is noticeable that at first purple is by far the more popular of the two, being used in large masses, and even for the flesh of men in many cases; but in the later black-figured vases its use is largely discountenanced, and is at most employed for small details such as the folds or patterns of a dress. The incised lines, again, play a very important part in the technique of these vases. They are made with a hard-pointed tool of bone or iron while the clay is still moist, the outlines of all the figures being traced first, and the designs then filled in with black varnish. The next process was the addition of incised lines for the inner markings and finer details, after which the vase was sent to the furnace, and finally the purples and whites were added and a second baking completed the process of production.

Throughout this period a steady advance in drawing is noticeable, although in one direction there is a somewhat deplorable tendency to affectation and mannerism, which shows itself both in the drawing and in extravagant use of ornament. Another feature is one which is more or less common to all archaic art, but is especially noticeable in these vases—viz., the tendency to give tapering extremities to human figures, and this at times runs quite to extravagance (*see* Fig. 2).

FIG. 2.—Corintho-Attic Jug (Olpè), with Hunter returning from the Chase. "Minute" style; one-third original.

The treatment of drapery is interesting, and may be regarded as a fair indication of date. The chiton, or long garment ordinarily worn by women, is at first straight, with rigid stripes of purple on black; then patterns are incised or painted in white on the black; the waist is generally very small, and bound tightly with a broad girdle. By degrees the lines of the folds take an oblique direction, as if to indicate motion; while an upper garment, the himation, or mantle, is now introduced with marked effect in the direction of oblique flowing lines or angular falling folds.

Another important feature of black-figured vases is the treatment of decorative patterns, which in this period become almost stereotyped. Thus on the amphoræ certain patterns are always employed to decorate certain parts of the vase; again, on the kylikes, in the latest development, a large eye is always painted on either side of the handles, this particular object being chosen, probably, as best adapted to the space. Again, it seems to have been almost a rule at one time to decorate the interior of a kylix with a full-face head of the Gorgon Medusa, not painted in black on a red ground, but left in the red clay

while the whole of the surrounding surface is black. It will be seen that this is practically the method of the succeeding red-figure style; and it has been supposed that this treatment of the Gorgon head was one circumstance which led to the evolution of that method.

We come now to what is, perhaps, the most important, and certainly the most interesting, aspect of the Athenian black-figured vases, namely, the subjects painted on them. These may conveniently be divided into six classes, as follows:

1. Representations of myths connected with Olympian deities, such as the birth of Athena from the head of Zeus.
2. Representations of Dionysos and his attendant Satyrs, Mænads, etc.
3. The labours and exploits of Herakles.
4. Subjects taken from the Homeric poems or other sources dealing with the tale of Troy.
5. Other mythological subjects, such as the exploits of Perseus and Theseus.
6. Subjects taken from daily life, such as athletic contests, battle scenes, etc.

It should be noted that this classification of subjects holds good throughout the history of vase painting—at least with some slight modifications; but it is in the period with which we have to deal that the subjects present the greatest and most varied interest, owing chiefly to the

FIG. 3.—Athenian Amphora, with Dionysos and Eyes; one-third original.

prevalent fondness for myth and legend. In the later periods the human interest tends to predominate.

In the mythological scenes the most remarkable feature is the adoption of certain fixed compositions of figures or types; a scheme of design for any given subject, once adopted, becomes conventionalized, and is adhered to with only minor variations, which do not affect the main design. An example of one of these types is given in Fig. 4. In all representations of the Judgment of Paris the same grouping of the figures is employed, but variety is introduced by omitting Paris or one of the goddesses.

Among the favourite subjects with vase painters of this period are: the combat of the gods and giants, the birth of Athena (*see ante*), Peleus wrestling with Thetis, Theseus slaying the Minotaur, Herakles conveyed by

FIG. 4.—Amphora, with Judgment of Paris. Athenian Fabric; about one-fifth original.

Athena in her chariot to Olympus, and contests in which that hero took part, such as his encounter with the Nemean lion, with the triple-bodied monster Geryon, or with the Amazons.

Only one instance of a historical scene is known on the black-figured vases—on an amphora in the Louvre, which represents Crœsus, King of Lydia, seated on his funeral pyre and pouring a libation. The story is told by Herodotos. We may also recall the cup described on page 152, with Arkesilaos of Cyrene weighing out the silphium.

Among the scenes from daily life an interesting subject is seen on a number of hydriæ (pitchers) which indicates the use to which this particular vase was put. A building is depicted containing a fountain or spring, at which girls are seen filling their hydriæ, while others bring theirs up to be filled or carry them away on their heads. On one example in the British Museum (*see* Fig. 5) the famous well of Callirrhoe at Athens is depicted; on another possibly that of Peirene at Corinth.

A most important class which must here be mentioned, is formed by the Panathenaic amphoræ, or vases given as prizes in the games at Athens in honour of Athena. On one side is always depicted a figure of the goddess herself; on the other, the contest for which the prize was given. Usually the vase is inscribed, "I am a prize from the games at Athens." It is interesting to note in connection with these vases that the black-figure method was adhered to on them, for religious reasons, down to the end of the fourth century B.C.: that is, as long as they continued to be made, although on other vases this method was given up at the beginning of the fifth century.

Another class of vases which for religious reasons

preserved the old style of painting through the fifth century has come to light in recent years, on the site of the temple of the Cabeiri at Thebes. The Cabeiri were mystical deities about whom very little is known; but it appears that ribaldry and grotesque caricature played a considerable part in their religion, and probably burlesque representations of myths were performed as part of the rites, and were further depicted on the vases dedicated in the temple, as on most of these vases we find caricatures of mythological scenes, such as Circe offering the magic potion to Odysseus.

A new development of technique towards the end of the sixth century is seen in a class of vases with white ground instead of red—a method which is supposed to have been

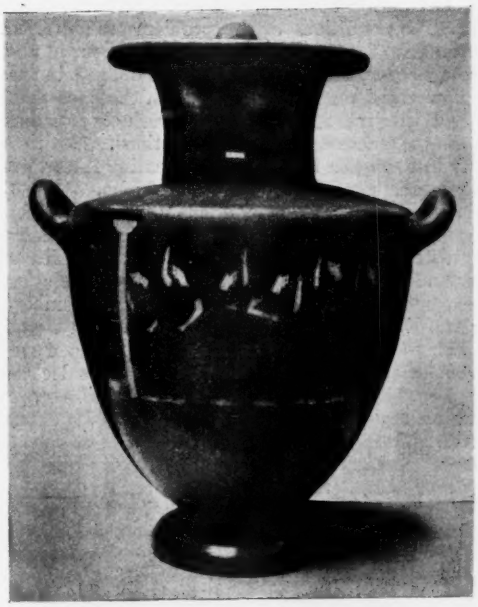


FIG. 5.—Athenian Hydria (Pitcher), with Girls drawing Water at the Fountain of Callirrhoe; about one-fifth original.

introduced by the artist Nikosthenes, a man of considerable fertility of invention, who also introduced a new form of amphora. In several vases signed by him the clay is covered with the creamy white slip which is characteristic of the class of which we are speaking. Some specimens of this group are very effective, but they are generally of small size.

It will be necessary to add a few words on the other Athenian artists who during this period left their signatures on their productions. They fall roughly into three or four classes: (1) the earliest group, at the head of which stand the artists of the François Vase described in a previous page, Klitias and Ergotimos; (2) the so-called minor artists, the chief names being Glaukytes, Tleson, and Xenocles; (3) the artists of the "affected" or "minute" style, such as Exekias and Amasis; (4) the artists who combine the black-figure and red-figure methods, Pamphaios, Nikosthenes, and Andokides. This classification is roughly chronological.

The "minor artists" in a way may be regarded as the forerunners of the great vase painters of the succeeding period, as they turned their attention almost exclusively to the decoration of the kylix.

In the next paper we shall see how the humble efforts of the "minor artists" led by degrees to the beautiful creations of their successors. In the present stage we find the decoration limited to one or two small figures on either side of the exterior, or a single figure, while many bear nothing but the signature of the artist or some appropriate motto, such as "Welcome and drink deep," or "So-and-so is fair." On the later unsigned kylikes the decoration becomes very rude and careless, although more attention is paid to choice of figure-subjects than by the "minor artists."

The artists of the "affected" style appear to be descendants of those who produced the so-called Peloponnesian vases, to which we have referred in connection with the François Vase. The same tendency to minuteness and richness of detail, to tapering extremities of human figures, and delicacy of form and outline, is here visible, in conjunction with more advanced power of drawing and knowledge of technique. Still, the result is quaint rather than pleasing, although it must be remembered that this tendency to over-refinement and richness is characteristic of the end of the archaic period in all branches of Greek art, and the result of a tendency which is swept away by the wave of athleticism and simple idealism which spread over the cultured Greek world in the fifth century.

It must, however, be reserved for the next article to treat of the causes which led to the change of artistic methods under Nikosthenes and his contemporaries, and the results which were brought about by that development.

COMETS OF SHORT PERIOD.

By W. E. PLUMMER, M.A., F.R.A.S.

WE have now to consider that large class of interesting comets which, moving as they undoubtedly do in elliptic paths of comparatively short period, have been seen once and then disappeared as completely as if their paths had been parabolic. Evidently this class of objects offers two riddles for solution. Why were they not seen before? And why have they never been seen since? The latter question does not, however, apply with the same force to those recently discovered comets which have not yet completed one revolution since they were first seen. It will be desirable to put these new comets in a class by themselves, and trust that time will prove them to be well-regulated members of the solar system. They cannot be said to have discredited themselves as yet, and the only suspicious circumstance connected with some of the members is, that they bear, in some of the elements of their orbits, a great family likeness to others that have had their chance of being repeatedly visible in our telescopes, and have not availed themselves of their full opportunities. We will give this list first, and make a few comments upon the more suspicious, and for this reason, possibly, the more interesting members of the group. The order of arrangement is again that of increasing mean distance from the sun.

Ordinary Designation of the Comet.	Period in Years.	Date of last Perihelion Passage.	Approximate Date of next Return.	Aphelion Distance in Terms of Earth's Distance.
1894 V. E. Swift	5·863	1894, Oct. 12	1900, Aug. 23	5·111
1892 V. Barnard	6·304	1892, Dec. 11	1899, April 1	5·396
1890 VII. Spitaler	6·381	1890, Oct. 26	1897, Mar. 14	5·063
1892 III. Holmes	6·904	1892, June 13	1899, May 9	5·112
1889 V. Brooks	7·072	1889, Sept. 30	1896, Oct. 26	5·419
1895 II. Swift	7·19	1895, Aug. 21	1902, Oct. 30	6·150
1894 I. Denning	7·373	1894, Feb. 4	1901, June 19	6·429
1889 VI. Swift	8·534	1889, Nov. 29	1898, June 12	6·998

XUM

Here we have eight comets introduced into the system in the short space of six years—on the average, more than one annually—and yet the total number of elliptic comets of approximately this period is only about thirty, including those that are lost and some whose periodicity is very uncertain, owing to defective observations made in the last century. Evidently, if this rate of increase was only approximately correct, the number now known should be far greater. Some in this catalogue, it is true, have been very faint objects, and would probably have passed undetected in days when telescopes were smaller or searchers fewer in number. Still, as pointed out in my article in the February issue, this suggestion does not altogether explain the frequency with which elliptic comets are now met with. Another very obvious suggestion presents itself. Is it possible that these objects are not all independent? May not some of the older and lost comets take upon themselves new shapes—move along strange and unrecognized paths under the influence of planetary perturbation, exerted upon them at some period in their career subsequent to our observation of them?

In this question we have implicitly two suggestions: the possibility of identity and the possibility of intimate connection between comets, arising presumably from having sprung originally from one parent stock; for it is necessary to bear in mind that other causes than planetary perturbation may be operative. We have seen Biela split itself into two sections, and the dichotomized comet pursue a bifurcated path. It may not be possible to demonstrate the cause of this disruption with certainty, though the behaviour of other comets, particularly the perplexing and inexplicable changes in brilliancy which they present to us at successive returns, and even while under observation, suggests that it was more probably due to some mechanical agency within itself than to any external force. In this particular case of Biela the two separated portions kept near each other, and came up to perihelion together within a day; but had the operating cause been greater, it is easy to imagine that a longer space of time would have separated the return of the two fragments, which, pursuing paths wider asunder, would have been submitted to different effects of perturbation, and the other elements of the orbit would have differed proportionately. Or suppose, the disruptive force being the same, several revolutions had been completed without the possibility of observing the comet; the disconnected portions would have separated more and more at each successive return, till it is quite possible only one of the components would have been seen. In the great comets of 1843 I., 1880 I., and 1882 II., we appear to have an instance of more violent disruption, in which one may suggest that some giant comet, carrying in itself greater forces, and consequently greater opportunities for producing catastrophe, has so violently dismembered itself that its several portions arrive at perihelion separated by years. The history of cometary astronomy contains so many surprises that it is almost impossible to reject any hypothesis as absolutely untenable, and it is unfortunately too easy to throw out suggestions that it is impossible to put to the test of experiment or efficient analysis. For instance, it is generally accepted now, with more or less certainty, that comet tails are due to a form of energy (electrical repulsion is the usual form the explanation takes) acting from the sun in a sense contrary to that of gravitation. But recent photographs of comet tails have indicated a shattering and discontinuity incompatible with a force regularly and continuously operative; and though this irregular structure may be explained by actual encounter with some asteroid, it is not impossible that the origin of disruption was present at the birth of the tail itself.

The only point that is here insisted upon is this: that while planetary perturbation, acting under laws that are perfectly understood and can be submitted to mathematical analysis or arithmetical calculation, is undoubtedly a great factor, either in the introduction of fresh cometary matter into the solar system or in controlling cometary matter that entered the solar system with the velocity due to parabolic, or approximately parabolic, motion, it is not necessarily the only force that can be invoked or employed as a working hypothesis. The suggestion of hypotheses without submitting them to adequate test is, perhaps, a confession of ignorance and an attempt to hide it; but the criteria applied by astronomers and mathematicians in this particular connection rarely give a certain and unambiguous result. The conditions of the problem are so varied, the opportunities of escape so numerous, the labour of absolute test so onerous, that we are too often obliged to accept a half answer, and console ourselves with the hope that time will fight in our favour by adding fresh observations and increasing the accuracy of the deductions. But time frequently introduces a fresh and complicating factor, without by any means removing the old perplexities.

As a good instance of the difficulties to be overcome in answering the question of a comet's origin, we may take the first item on the list (1894 V. Swift) and endeavour to understand the interesting problem it offers for solution and the means it supplies for that solution. On November 21st, 1894, Mr. E. Swift, the son of Prof. Lewis Swift, well and honourably known in connection with cometary discovery, picked up a faint comet at considerable southern declination. It had passed its perihelion and was growing fainter, but was moving northward, which slightly improved its chances of observation, and Prof. Barnard was able to follow it with the large refractor of the Lick Observatory till January 25th. We have, therefore, two months' intermittent observation of a faint nebulous patch by a few observers, no two of whom are likely to agree on the same precise point for measurement, to say nothing of the possibility of an alteration of shape. Yet out of these observations, which cover so small an arc of an ellipse which requires six years to complete its revolution, the entire curve has to be constructed. Such procedure puts the *ex pede Herculem* principle to its fullest stretch. Nevertheless, as soon as a few observations permitted the first rough determination of an orbit, M. Schulhof announced unhesitatingly that it was the lost comet of De Vico, that had previously been seen once, and once only, in 1844. If this conjecture be well founded, evidently the comet has no right to a separate place on the list, any more than any other comet which may have been missed at one or several returns and subsequently recovered, of which examples were given in February. On what grounds, then, had M. Schulhof based his assertion?

The observations of the comet of 1844 had been submitted to a very critical discussion by the late Dr. Brunnow, and though the orbit was to some small extent uncertain the elements were fairly trustworthy, and resembled those of the parabola that Schulhof had computed from the first observations that had come to hand. It may be as well to mention here that this is the course uniformly pursued by computers. A parabolic orbit is first derived because the labour of computing elliptic elements is far greater, and to obtain accuracy comparable with that labour the elements should be based on observations extending over a longer period than is required to give fair accuracy in the case of parabolic motion. So complete was the resemblance between the new parabola and the old ellipse

that Schulhof at once, without waiting for additional observations, assumed a period very nearly that which Brunnow had assigned for the 1844 comet, and re-computed elliptic elements which subsequent care and additional information have not materially improved. Here is the first link in the chain of evidence, namely, that the motion of Swift's comet can be represented by elements whose period is suggested by that of De Vico's comet. But fifty years is a long time, and many alterations more or less serious must be expected to take place in the pure elliptic motion of a comet which runs very nearly in the plane of the ecliptic, and must cross and recross the orbits of Mars and Jupiter several times, with the chance of approaching those planets more or less closely. To compute the perturbations of a comet for fifty years is a task which, though it would effectually remove the objection, is not lightly to be undertaken; and to enter upon such an enquiry we want what we have not got—either very accurate knowledge of the elements in 1844, or the present condition of things in 1894. Errors accumulate with the time. Dr. Brunnow had assigned 5·5 years for the period of De Vico; Schulhof preferred 5·8 years for Swift. So far as these figures go, at each return the error would be increased by three-tenths of a year. But mathematical analysis has been able to indicate the direction that perturbations will take without the labour of actual calculation, and it has been demonstrated by M. Callandreau that in the case of a comet having a small inclination to the plane of the ecliptic, and moving about the sun in the same direction in which the planets revolve, the action of the planets will continually tend to increase the longitude of the perihelion and diminish that of the node. Fortunately the means were at hand to settle this question. Le Verrier had believed that the comet of 1844 was the reappearance of one that had been seen in 1678. If this be the case, the fact that it lay dormant, so to speak, for so many years is typical of its more recent behaviour; but in investigating this question Le Verrier had carried back the perturbations and supplied elements for various dates in its past history. We are simply concerned in the motion of the perihelion and the node, and for these Le Verrier gives

	Longitude of Perihelion.	Longitude of Node.
For 1799	334° 24′	135° 18′
,, 1811	338° 24′	118° 29′
,, 1844	342° 31′	63° 50′

while M. Schulhof's hastily computed element gives

For 1894	345° 20′	43° 41′

Here we have clearly exhibited the direct motion of the perihelion and the retrograde motion of the node, tending to complete the train of evidence in favour of identity. But the argument is not yet complete. Dr. Brunnow's elements showed that De Vico's comet should approach Jupiter towards the end of 1885. Dr. Schulhof's elements show that the 1894 comet was actually near Jupiter in 1885-86, and this might well explain the alteration of the period from 5·5 years to 5·8 years.

At this point Prof. Chandler, whose name is so well known in connection with the variation of geographical latitude, took up the subject; and after having improved the elements by incorporating Prof. Barnard's latest observations, computed the perturbations of the comet back to the time before the last approach to Jupiter occurred. It is not possible to compute these perturbations with absolute certainty, because the unavoidable errors in the elements do not permit the distance of the comet from Jupiter—on which, of course, the amount of disturbance depends—to be determined with accuracy. The result of his calculations, however, is to show that all the elements have a tendency to approach those that Dr. Brunnow assigned in 1844, when brought up to the same date. These are given side by side. In the first column are Brunnow's elements brought up to 1882; in the second the most probable elements that can be assigned before the very considerable perturbations by Jupiter were effected; in the third the most trustworthy elements Prof. Chandler could derive from the inadequate materials at his hand.

	Brunnow, 1882.	Before Perturbation, 1883.	Actual Orbit, 1894.
Arc between perihelion and node	278° 49′	283° 7′	296° 34′
Longitude of node	64° 20′	60° 24′	48° 41′
Inclination to ecliptic	2° 55′	2° 53′	2° 58′
Eccentricity	0·61765	0·60282	0·57190
Nearest approach to sun ...	1·1864	1·2548	1·3920
Period in years	5·466	5·615	5·863

Here the agreement is very satisfactory and gratifying, since the greater part of the observed difference between Brunnow's orbit (1844) and Chandler's (1894) has disappeared.

There still remains the question, Will time fight on our side, and by adding fresh information remove any shadow of doubt which hangs over the question of identity? Evidently, if we should see the comet again six years hence, we could get a very accurate idea of the mean motion, and so trace back the path of the comet with greater certainty. We have, however, to face the fact that in 1897 a still closer approach to Jupiter is certain; and Mr. Chandler, in summing up the probability of the new conditions under which the comet will find itself, says: "I am inclined to anticipate that, with the present appearance, our acquaintance with this interesting body will unfortunately be brought to an end. The present perihelion distance will probably be changed by Jupiter in 1897 to one considerably beyond the orbit of Mars, so that unless a favourable reversion of the change in brilliancy which apparently took place between 1844 and 1894 should occur, it will in all likelihood hereafter be invisible; at least until, at some future approach to the critical point of disturbance near longitude 165°, simultaneously with Jupiter, it shall be thrown into a path in which, near perihelion, it will be again in reach of our telescopes."

I have dealt with this comet at length because it offers a typical instance of the difficulties and of the degree of success that attend inquiries of this nature. The history contains all the uncertainties that arise from imperfect knowledge of the actual path in which the comet is moving at the time of observation, the laborious nature of the arithmetical calculations involved, and of the uncertain element that lapse of time introduces. There is, it is true, another test, easy of application, known as "Tisserand's criterion;" but this test, for reasons which I shall hope to explain hereafter, is peculiarly apt to speak with uncertain sound. I have not introduced it here, though applicable, for its use can be better illustrated in the case of some of the other comets of which mention has been made in the first paragraph. In the case of De Vico's comet, here considered, it will be admitted that the final result appears gratifying; but no light is thrown on the further interesting question of actual identity as opposed to an intimate connection. In the present state of our knowledge, or of our ignorance, of the internal constitution of comets, it is not possible to apply mathematical analysis. The problem presents itself simply as one of disturbed elliptic motion, and the interest turns on the ingenuity with which various astronomers have successfully encountered and overcome the intricacies of the subject.

XUM

PHOTOGRAPH OF THE REGION OF THE SPIRAL NEBULA MESSIER 33 TRIANGULI.

By ISAAC ROBERTS, D.Sc., F.R.S.

THE photograph was taken with the Cooke five-inch lens on the 14th November, 1895, with exposure of the plate during two hours and fifteen minutes.

The centre of the plate is about R.A. 1h. 28m., declination north 30° 7′; and the area of the sky covered is 8·1 degrees from north to south and 6·1 degrees from *preceding* to *following*, the nebula being at the centre.

Scale, one millimètre to one hundred and twenty-one seconds of arc.

Sir J. Herschel (N. G. C., No. 598; G. C., No. 352) and Lord Rosse (*Observations of Nebulæ and Clusters of Stars*, p. 20) record many observations made by them of this spiral nebula, and by the aid of their large instruments, used with great skill and perseverance, they accomplished all that was possible in the way of descriptive matter and delineation to present the object in an intelligible form to astronomers. It is no adverse reflection upon their work if they did not succeed in the accomplishment of their object, for such is the vast area of the nebula, the complexity of its structure, and the faintness of parts of the nebulosity, that the best efforts by eye and hand could not possibly delineate it.

The photograph shows the nebula to be about sixty-two minutes of arc in length from *north following* to *south preceding*, and thirty-five minutes in breadth from *south following* to *north preceding*.

There are two large, very prominent spiral arms, with their respective curvatures facing north and south, and the curves are approximately symmetrical from their extremities to their point of junction at the centre of revolution, where there is a nebulous star, of about tenth magnitude, with dense nebulosity surrounding it—elongated in north and south directions. Involved in this nebulosity are three bright stars and several faint nebulous stars; the two arms are also crowded with well-defined stars and faint nebulous stars with nebulosity between them, and it is to the combined effect of these that the defined forms of the arms are due. There are also subsidiary arms, less well-defined, trending towards the centre of revolution, which are constituted of interrupted streams of faint stars and nebulosity intermingled together.

There are detached outliers of nebulosity with many small well-defined stars as well as nebulous stars involved in them; also isolated nebulous stars on the extreme boundaries of the nebula.

The larger photograph taken with the twenty-inch reflector simultaneously with that here annexed shows more clearly the details referred to, but the area of the sky delineated is limited to four square degrees.

In studying these photographs the question is very naturally presented to us, What is the cause that produced this vast stellar and nebulous whirlpool in space? Two answers may be suggested:—(1) An explosive disruption of a large body; (2) collision between two bodies moving from opposite directions. The colliding bodies might be two stars, two nebulæ, or two meteor streams; and if we judge by the widely scattered vortical distribution of the star-like and nebulous matter shown on the photographs, it is very probable that the collision of two streams of meteorites would be the cause.

Many other spiral nebulæ have already been photographed, and the appearance of each of them would well fit into the hypothesis suggested by Prof. Lockyer of the collision of streams of meteoric matter.

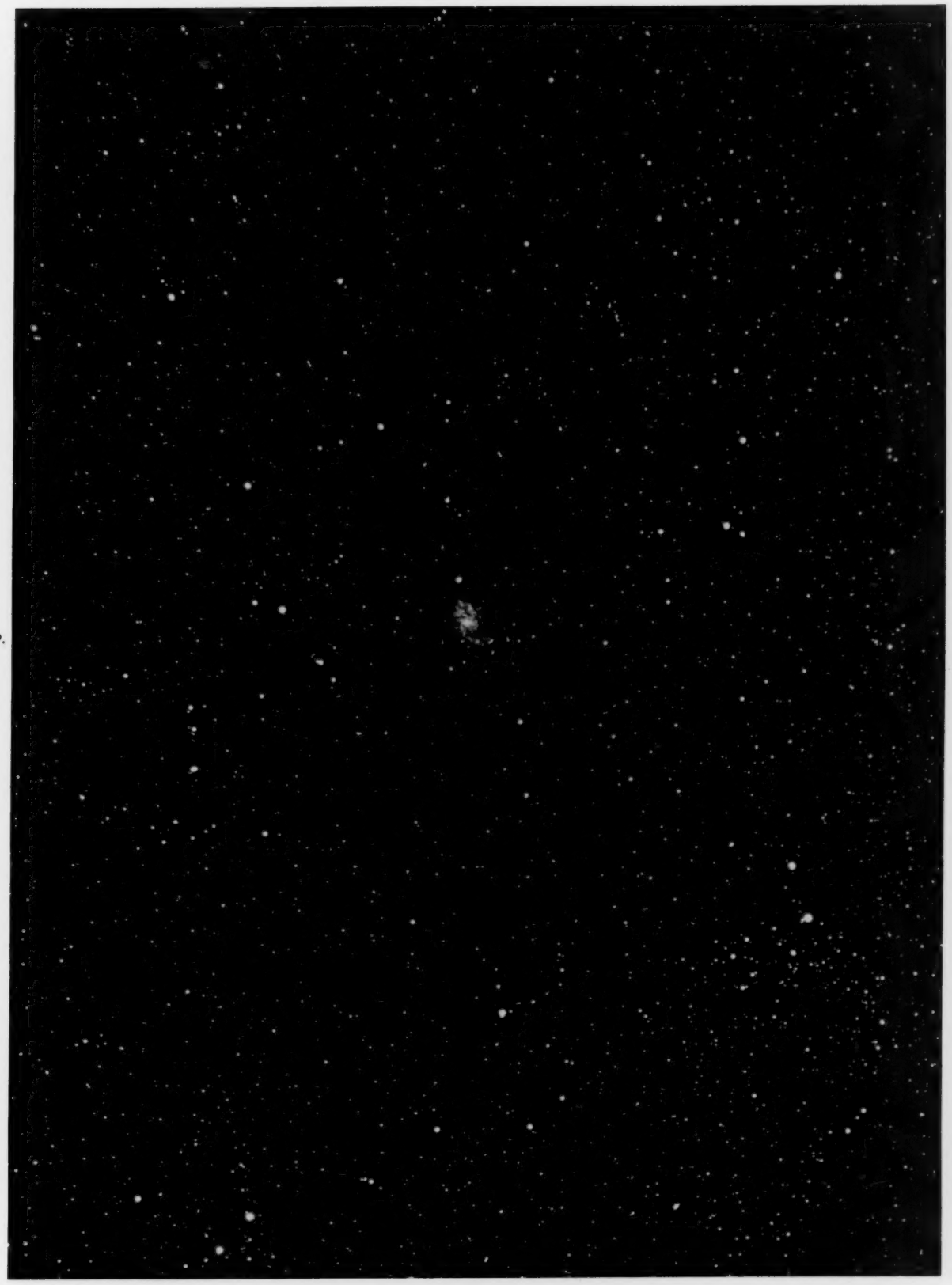
Notices of Books.

Remarkable Eclipses, by W. T. Lynn (Edward Stanford, 6d.), is apologetically presented by the author as but "a little one." Here the apology is scarcely appropriate, for many readers would gladly see a larger work, tracing and explaining the allusions to astronomy in ancient and mediæval literature, from Mr. Lynn's pen. Mr. Lynn roughly divides the book into two periods—first, that of those eclipses which took place prior to A.D. 1715, the year when the prominences were first seen; the other, that of those subsequent to that date. The first authentic recorded eclipse he dates as recently as B.C. 776, as found in the "*Ste-King*," which is Mr. Lynn's free rendering of the title of the Chinese chronicle the "*Shu Ching*." But according to a series of papers on "Some Astronomical Records in Ancient Chinese Books," published in "The Observatory" in 1895, a noteworthy eclipse took place at An Yi Hsien on October 22nd, 2136 B.C., from 10 to 12.30 in the daytime, which may therefore surely be allowed a place in eclipse history. Mr. Lynn has long been known as a first authority on ancient eclipses, and the first portion of this his most recent work ably sustains his reputation. The latter part is the most lucid and accurate compendium of the results of modern eclipses that we have seen in such small compass. On page 38, however, he has been led into error on one point. Speaking of the eclipse of 1878 he says, "The corona was smaller and less brilliant than in those of the last-mentioned eclipses"—*i.e.*, 1869, 1870, and 1871. This was scarcely the case. As to its form, it was indeed of a most strongly marked minimum type, but it was of unusual extent and more than average brilliancy. These are the only corrections we note in a most readable and convenient little manual, the low price of which should certainly secure it a large sale.

Historical and Future Eclipses. By Rev. S. J. Johnson, M.A., F.R.A.S. (Parker & Co.) Illustrated. 4s. 6d. We are sorry not to be able to accord Mr. Johnson's book by any means unqualified praise. It is in effect a second edition of "Eclipses, Past and Future," published by the same author in 1874, and to which a small supplement was added in 1889. As it originally appeared the book had very considerable merits. It passed in brief but sufficient review nearly all the more important eclipses of the past, and gave some interesting particulars of a large number of eclipses to come. But in a second edition, published after an interval of almost a quarter of a century, we expect to find not merely all the information of the first edition, but also its errors corrected and its general character improved. The reverse is the case. The information given in the original work concerning the eclipses of 1896 to 1900—those most important to us just now—is not expanded but expunged. The misprint of "Ophinchus" for "Ophiuchus"—excusable, perhaps, in a first edition—is developed systematically throughout the present book. The physical details respecting the sun and planets, meagre enough in the earlier volume, remain nearly in the same condition, no sustained attempt having been made to bring them up to date; whilst the last page of the book repeats a long-exploded idea. The new matter is not always correct. Oppolzer's "Canon" is stated not to give solar eclipses in the southern hemisphere. Curiously enough, whilst the particulars of the eclipses close at hand are wholly eliminated, and those relatively near are often much shortened, the list of future eclipses is carried up to 2491, several centuries further than before. In short, a work with much to recommend it, and which, with a little

PHOTOGRAPH OF THE REGION OF THE SPIRAL NEBULA MESSIER 33 TRIANGULI.

S.



P. F.

N.

XUM

care in revision, could have been rendered faultless, has been but little altered after twenty years' interval, and then often for the worse.

A Contribution to our Knowledge of Seedlings. By the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S. (Kegan Paul & Co.) Illustrated. 5s. This—the seventy-ninth volume in the well-known International Scientific Series—is an abridged edition of a larger work published under the same title. It is described upon the title-page as a "popular edition," but this must only be taken in a comparative sense, for no one unfamiliar with botanical phraseology could properly understand the contents. Readers who have received that preliminary education will, however, be interested in Sir John Lubbock's attempt to throw light upon an important stage in the life-history of plants. The forms of many interesting cotyledons are described and figured, and explanations are offered why cotyledons differ from the subsequent leaves and from one another. In a previous work on "Flowers, Fruits, and Leaves," the author gave an account of the causes which determine the form and structure of seeds and fruits. The present work, with its many suggestive ideas, forms a worthy companion to its forerunner.

Minerals, and How to Study Them: a Book for Beginners in Mineralogy. By Edward Salisbury Dana. (New York: John Wiley & Sons. London: Chapman & Hall.) Illustrated. Students of mineralogy are not very numerous, but this volume should certainly be the means of adding to their ranks. Written by a master of the subject, and with the desire to encourage those who wish to learn about minerals, the volume admirably supplies the wants of elementary students. Many guide-books to fields of scientific knowledge fail to point out the pitfalls and difficulties which are always liable to crop up in practical work, and which frequently discourage beginners. But this is not so in Prof. Dana's work. By clear descriptions he lights the way of the student; and while he directs attention to this or that point of interest in the form, structure, or other characters of minerals, he gives, where necessary, a caution as to sources of error in an experimental examination. The arrangement of matter is excellent. Sections on forms of crystals and kinds of structure, physical characters, chemical characters, and the use of the blow-pipe, form nearly one-half of the book; the remainder is concerned with the description of mineral species and the determination of minerals. Numerous illustrations, most of them new, are distributed through the book, and these, with the lucid text, make up a volume which will cultivate powers of observation, and excite interest in a neglected science.

Discoveries and Inventions of the Nineteenth Century. By Robert Routledge, B.Sc., F.C.S. Eleventh Edition. (George Routledge & Sons.) Illustrated. When a work has reached its eleventh edition it is almost beyond the effects of criticism. Little need, therefore, be said about the volume before us except that it contains a good general account of engineering achievements and scientific discoveries, written in a style "understanded of the people," and liberally illustrated. Some parts of the book have been brought up to date much more thoroughly than others. Thus the statement that "the number of observed bright lines in the iron spectrum has been since [that is, since Kirchhoff] extended to four hundred and sixty, and yet each is found to have its exact counterpart in a dark solar line," is behind the times, for nearly two thousand iron lines have been identified in the solar spectrum by Rowland. Several other cases of imperfect revision have been noticed in glancing through the book; but, taken as a whole, the new edition of the work deserves to be as successful as previous ones.

Heating and Ventilating Buildings. By Prof. Rolla C. Carpenter. (New York: Wiley & Sons. London: Chapman & Hall.) Illustrated. Would that all the tradesmen who call themselves plumbers and hot-water engineers had to give evidence of familiarity with the contents of this book before they were permitted to practise. The general principles of heating and ventilation are usually outside the knowledge of workers with lead and solder, and even in technological classes they are neglected in order to hurry on to applications. Prof. Carpenter gives satisfactory accounts of principles of ventilation, the nature and properties of heat, the radiation of heat, and similar matters, before describing the methods of application to the erection of systems of heating and ventilating. By so doing he shows that he knows the value which purely scientific facts possess for the self-styled "practical men," who often despise knowledge of which the industrial bearing is not apparent. With the clear and concise introductory chapters as a foundation, the reader of the work will be able to follow intelligently the descriptions of various practical methods and systems employed in heating and ventilating buildings. Steam and hot water systems, heating with hot air, with exhaust steam, and with electricity are all considered, and practical directions for their construction and installation are given. Throughout the book the information is sound and practicable. We offer our congratulations to Prof. Carpenter at having produced a splendid general treatise on a branch of engineering little studied in this country.

SHORT NOTICES.

The National Geographic Magazine (U.S.A.). (London: E. Marlborough & Co.) Issued from Washington as the organ of the National Geographic Society of America, this excellent monthly may now be obtained in London or Paris.

The Interchangeable Index. (Spink & Son, Piccadilly.) This is a most ingenious invention for the cataloguing of all kinds of collections The method is simplicity itself. The desired narrative is written upon specially prepared slips, which are then inserted in the pages of a quarto volume, having slits already cut to receive them. The slips are of various sizes, and are of course interchangeable, so that perfect alphabetical order is at any time possible by the simple process of inserting your latest addition in its proper place, and then moving the others the necessary spaces forward. Of the smaller slip, the volume before us will take no less than 480.

The Condition of Working Women and the Factory Acts. By Jessie Boucherett and Helen Blackburn. (Elliot Stock.) This little book is an interesting plea for the direct representation of women in the construction of factory legislation, which the writers consider to be unduly oppressive to the interests of working women.

Theatre Panics and their Cure. By Archd. Young. (Andrew Elliot, Edinburgh.) This is another attempt to deal with the terrible dangers arising from a panic in theatres and other buildings when crowded with people. Mr. Young's ideas are admirably illustrated in a series of plans by Mr. Thomas T. Paterson.

The Observer. (Edward F. Bigelow, Portland, Conn.) The editors are to be congratulated upon their energetic attempt to further the cause of popular work in nature studies.

Roman "First Brass" Coins. By Leopold A. D. Montague. (C. H. Nunn, Bury St. Edmunds.) A cheap guide to the Roman brass coinage, and very useful to collectors.

Messrs. Macmillan & Bowes send us a catalogue (No. 257) of valuable books on mathematics and astronomy from the libraries of the late Mr. Arthur Cowper Ranyard and Prof. Henry J. Stephen Smith.

We notice that Mr. R. Kanthack, of 18, Berners Street, London, has been appointed sole agent in the United Kingdom and Colonies for Messrs. C. A. Steinheil Söhne, the famous astronomical instrument makers of Munich.

BOOKS RECEIVED.

Mars. By Percival Lowell. (Longmans.) Illustrated. 12s. 6d.

The Indian Calendar. By Robert Sewell and S. B. Dikshit. With Tables of Eclipses visible in India. By Dr. R. Schraur. (Swan, Sonnenschein.) 31s. 6s.

Miscellaneous Papers. By Heinrich Hertz Translated by D. E. Jones, B.Sc., and G. A. Schott, B.A., B.Sc. (Macmillan.) 10s.

Water Supply. By W. P. Mason. (New York: Wiley. London: Chapman & Hall.) Illustrated. 21s.

A Dictionary of the Names of Minerals. By A. H. Chester, E.M., Ph.D., Sc.D. (New York: Wiley. London: Chapman & Hall.) 15s.

Press Working of Metals. By Oberlin Smith. (New York: Wiley. London: Chapman & Hall.) Illustrated. 12s. 6d.

Chemistry in Daily Life. By Dr. Lassar-Cohn. Translated by M. M. Pattison Muir, M.A. (Grevel & Co.) Illustrated. 6s.

A Manual of Mending and Repairing. By C. G. Leland. (Chatto & Windus.) Illustrated. 5s.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

SEA SICKNESS: A MECHANICAL REMEDY.

To the Editors of KNOWLEDGE.

SIRS,—Some years ago, when crossing the Irish Channel on board a passenger steamer, with a very rough sea, it occurred to me that as the motions of the vessel produced sea sickness, it might be possible to so utilize such motions as to prevent that disagreeable malady.

The vessel has three kinds of motion: a rising and falling motion of the entire vessel; an oscillatory motion longitudinally about its centre of gravity; and a transverse rolling motion.

Without going into the technicalities of these motions, I may say that I treated the longitudinal motions as having a tendency to drive matter, centrifugally, towards the head and stern, and the rolling motions as having a similar tendency to drive matter outwards from the centre of such motions.

Now, the entrance to the stomach is on the left side of the body, the œsophagus end, and the exit is on the right side, the pyloric orifice; and my experiment consisted in utilizing the longitudinal motions so as to keep the food *in* the stomach, and utilizing the rolling motions so as to assist the natural operations of the œsophagus in propelling the food towards the pyloric orifice. This I effected by selecting a couch arranged in a line with the keel: lying with my head *towards* the engine room, and lying upon my *left* side. The experiment was entirely successful, and I have always adopted it in rough seas, when a suitable berth could be obtained. The pitching and rolling of the vessel had the desired effect of aiding the retention of the food, and the rising and falling of the entire vessel was immaterial, and did not in the least interfere with my comfort. The experiment cannot be carried out with berths arranged athwart-ship. THOMAS MOY.

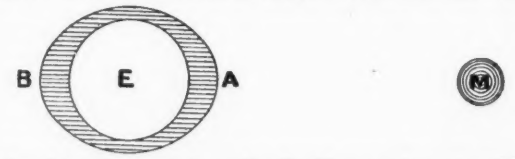
WAVES.

To the Editors of KNOWLEDGE.

SIRS,—Allow me to make a remark about Mr. Vaughan Cornish's article on the "Tide Wave" in the May Number of KNOWLEDGE.

I find as explanation for the secondary tide formed by the moon that the solid globe (that is, the earth as a whole) is pulled away from the waters, leaving them heaped up; in other words, the earth is pulled out of its orbit, in which it revolves once a year round the sun, and undergoes a daily deviation (not a monthly one, which it actually does), whilst the waters on the opposite side of the earth are not subject to that deviation, because they are not sufficiently attracted. That the attraction is less powerful on the opposite side is quite true, but the conclusion I draw from this fact is different from that drawn by Mr. Cornish.

The large circle E represents the earth, the smaller M the moon, and the shaded part round E the water surrounding the earth, A and B being two points diametrically opposite on which there is high tide at the same time. The attraction of the moon accounts for the waters



being heaped up at A, as the liquid mass is more subject to that attraction than the solid earth. But is the earth itself as a whole pulled away from its orbit in a daily deviation? Observation teaches it is not. So the solid globe cannot actually be drawn away, and there must be another reason for the water bulging up at B. The attractive power of the moon is much smaller at B than at A, owing to the greater distance; and therefore the centrifugal force, which arises from the daily revolution of the earth round its axis, has the same effect at B as the attraction of the moon has at A—that is to say, owing to the centrifugal force the waters at B try to get away as far as possible from the centre of the earth, and cause the same bulging out that takes place at A.

I do not profess to have given in the above quite an exact and correct statement of the facts. It seems to me, however, more plausible than the theory of the solid globe being pulled away from the waters. E. WOHLWILL.

TIDE OF THE RIVER WYE.

The second paragraph of Professor Logan Lobley's note upon this subject in the last number of KNOWLEDGE (at page 130) was incorrectly printed. It should read as follows: "A seismic wave, or one caused by a volcanic eruption, although it may reach coasts at a great distance if there is no intervening land, is non-coincident with the cosmic tidal wave."

ABOUT DEATH RATES.

By ALEX. B. MACDOWALL, M.A.

WE live in an age of sanitation. In the course of a generation the conditions of life have in some ways been sensibly improved. It is a well-known fact that the death rate has declined. This result has naturally been an occasion for much—perhaps excessive—jubilation. There are sanguine spirits who seem to see in the near future a complete victory over all the ills that flesh is heir to.

It is not so generally known that this improvement in the death rate is not an all-round one; that is to say, it holds good only, as we may put it, for the earlier half of life. The death rate of middle-aged and elderly people has increased. I will illustrate this with a diagram (Fig. 1).

This relates to males, in England, of different age-groups, viz., 0 to 5, 45 to 55, 55 to 65, and 65 to 75. The first dotted curve shows the variation in the death rate of children. By a smoothing process the general course of the curve is brought out more clearly in the continuous curve, each year-point of which represents an average of ten (*e.g.*, that for 1848 the average of 1844 to 1853). Here we find a marked decline from about 1865.

When we come to the age-group forty-five to fifty-five, however, we encounter a general rise in the death rate; and the next two decade-groups (for which only the smooth curves are given) are of the same type.*

With regard to the omitted age-groups, the earlier ones, to thirty-five, all show a decline, and generally from the

* Each of these curves, or curve-groups, it will be seen, has its separate scale, and that of *a* is different from those of *b*, *c*, and *d*.

outset. The group thirty-five to forty-five, as also the two groups over seventy-five, show little change in the final result.

This rise in the death rate of adults—amounting, in those three groups, to about six, twelve, and seven per cent. respectively from first to last—presents an important problem in sociology.

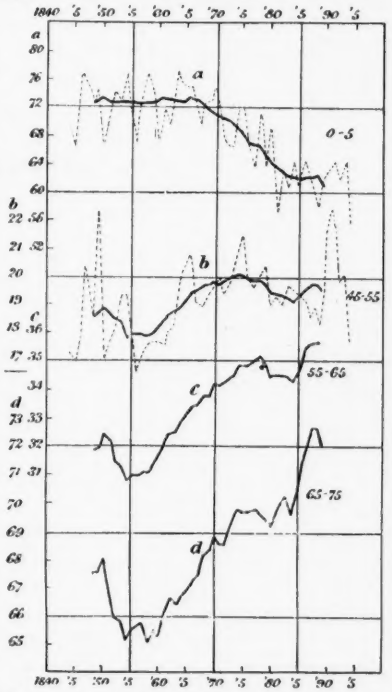


FIG. 1.—Death Rates of Males in different Age-groups (England).

The great world of London presents many startling contrasts in the conditions of life. It is not wonderful to find the ravages of death much more severe in one part than another. Here are two curves (upper part of Fig. 2) showing the history of the death rates of East and West London since 1851. Not only is the death rate of the Western District considerably under the other (say three to five in one thousand), but the improvement is greater and more continuous. The Eastern death rate rose in 1866 to 34·0 through the visitation of cholera, which chiefly affected East London; three-fourths of the total of deaths (three thousand six hundred and ninety-six) taking place in Eastern parishes. In 1854—another cholera year—the difference in mortality of the two districts was much less.

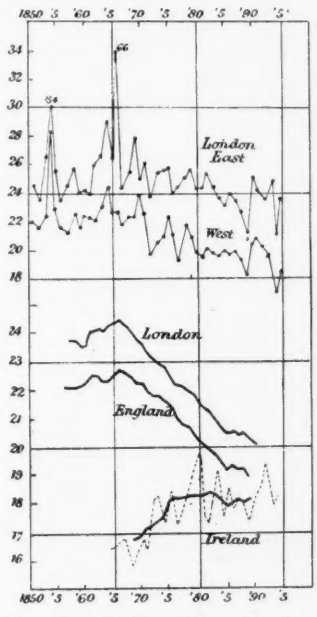


FIG. 2.—Death Rates (London, England, and Ireland)

It might possibly surprise some people to hear that the death rate for Ireland is generally less than that for England and Wales. We must remember that the population is more largely rural. In the lower part of Fig. 2 (dotted curve) is shown the course of the Irish death rate since 1864, and it is smoothed in the continuous curve (as before). Above are the smoothed curves of the death rates in England and in London. While the two latter curves have been going down almost continuously since 1866, the Irish curve shows an upward tendency from about the same date, followed by a nearly stationary condition since about 1875.

Here are the first and last figures of these smoothed curves:—

London	1857, 23·8;	1890, 20·1
England	1857, 22·1;	1889, 18·9
Ireland	1868, 16·8;	1889, 18·2

It is interesting to compare the death rates of various European countries through a series of years. Here (Fig. 3) is a group of curves showing the actual variations for England, Scotland, Belgium, Prussia, Austria, and France (each with its separate scale).

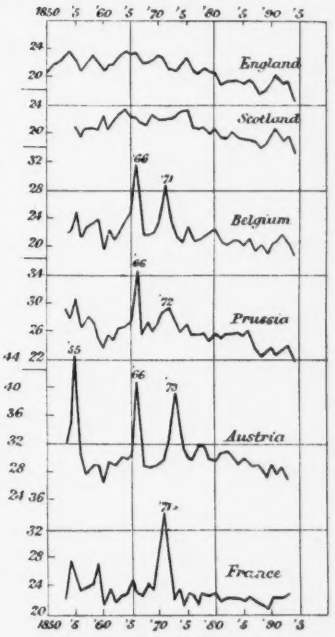


FIG. 3.—Death Rates in some European Countries.

There are some very conspicuous years in some of these curves, accounted for chiefly by cholera, or war, or (as in the case of 1866, in Austria and Prussia) by both.

In the general trend of most of these curves one may detect a considerable similarity. Thus we may make out by the eye, or by smoothing methods, a long wave rising from about 1860 to a crest something like a decade later, followed by a long downward slope, interrupted latterly, in some cases, by mortality from influenza. It would appear as though some common cause (possibly of climatic nature) were at work giving rise to this general uniformity of variation.

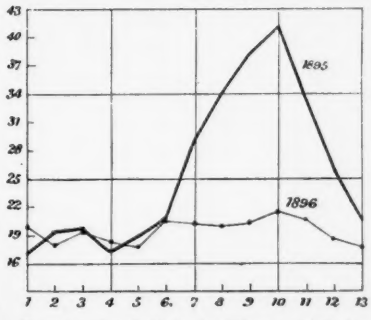


FIG. 4.—Death Rate in Weeks of First Quarter of 1895 and 1896 (London).

We have had a striking instance lately of the effect of cold and mild winter weather on our mortality. The first quarter of 1895 was intensely cold; the first quarter of 1896 very mild. Here is a diagram (Fig. 4) showing the London death rate in the thirteen weeks of those two quarters. In the fifth to the tenth week of 1895 the rate quickly rose till it was over forty; whereas in the first quarter of 1896 it did not reach twenty-two. The influence of temperature on health and life, however, is a question of no little complexity.

THE FOLDINGS OF THE ROCKS.

By PROF. J. LOGAN LOBLEY, F.G.S.

ALTHOUGH most observers of nature are fully cognizant of the inclination or "dip" of the stratified rocks, and well know that oblique beds seen in an exposure or section of these rocks are but parts of great folds, yet few are aware of the extent to which the sedimentary rocks have been disturbed from their original horizontality. It may even be said that few geologists, to whom rock-foldings are familiar, realize the aggregate magnitude, much less the momentous significance, of the plications of the stratified rocks. It may, therefore, be useful to present a few facts to bring home to the mind the vast extent to which the once horizontally deposited strata, forming the exterior rind of the globe, have been folded and plicated since they were completed sheets of rock.

Cultivated, verdure-covered, or wooded land so generally forms the surface, and conceals the underlying beds from observation in almost all generally known regions, that exposures of the rocks beneath the surface have to be sought for; but yet they are sufficiently numerous to reveal the general structure of the ground beneath us. Natural sections are seen in mountain precipices, torrent ravines, banks of rivers, and cliffs of the sea coast; while mining, quarrying, well sinking and boring, and road and railway engineering, with its excavations and tunnelling, supply many and most valuable artificial sections.

Although these exposures of the rocks forming the exterior crust of the earth show in many cases horizontal or only slightly inclined strata, yet so many present to view highly inclined beds, and these in so many widely separated parts of the world, that, in the words of Sir Archibald Geikie, "we may readily perceive that the normal structure of the visible part of the earth's crust is one of innumerable foldings of rocks." The examples that follow must, therefore, be regarded merely as typical illustrations, and not by any means as an exhaustive list of those that have been observed.

Our own country of England affords many remarkable examples of highly inclined and folded rocks. In Shropshire the Cambrian rocks of the Longmynd Hills are actually vertical, with beds of conglomerate in which the longer axes of the pebbles are upright; and so it is evident that these massive beds are but remnants of enormous folds, the upper parts of which—the crowns of the arches as it were—have been entirely removed. Such is also the case in the Isle of Wight, where, at both the east and the west end of the island, the stratification of the Chalk may be seen by the lines of flints to be almost vertical. In other places the rocks, though not so nearly vertical as in the above-named localities, are yet very highly inclined. In the Vallis Valley, near Frome in Somersetshire, the Carboniferous Limestone is at a very high angle—about seventy degrees—but overlaid by Jurassic rocks that are almost horizontal. The grand section of the Carboniferous Limestone in the gorge of the Avon below Bristol shows a dip of forty degrees throughout the whole section, which is fully a mile in length, giving the thickness of the formation. In the Mendip Hills the compression of the horizontal extension of the rocks by folding has been estimated to be as much as half of its original length. In many localities, too, the rocks are so plicated that they can only be called contorted, the bendings being so numerous in a small space and the angles so acute. Such are the Purbecks of Lulworth, in Dorsetshire, and the Lias of some sections in the Midlands. The remarkable Silurian inlier in the midst of the Dudley coalfield, forming the Wren's Nest, is but the summit of a fold of Wenlock Limestone that rises through the Coal Measures. Of large but less acute foldings there is an example to the west of the Malvern Hills, where the Wenlock Limestone is in a great synclinal that passes under the Ludlow, which at Ledbury becomes an anticlinal; and in the same county of Hereford the remarkable "valley of elevation" at Woolhope gives a conspicuous anticlinal of Upper Silurian rocks. A very fine example of folding, showing both the synclinal and anticlinal fold on a large scale, is presented by the London Basin and the great valley of the Weald to the south, London being over a synclinal of the Chalk which rises to the south and forms the North Downs that overlook the great Weald Vale, through which passes from east to west an anticlinal axis from which the beds dip to the north and south.

In Wales the examples of inclined and folded rocks are almost as numerous as the sections, both North and South Wales being formed for the most part by greatly folded Palæozoic rocks. A remnant of a vast synclinal fold of Caradoc rocks forms the upper part of Snowdon, in North Wales, and a great anticlinal of Ludlow rocks gives the Alt Fawr and Corw-y-Fan of Brecon, in South Wales; while marvellously contorted rocks, most acutely bent, may be seen at Holyhead Island, opposite the South Stack. Rock foldings and acute plications are as conspicuously displayed in Scotland and Ireland. Indeed, in some parts of Scotland there is seen an actual inversion of strata, the beds being bent back on themselves. On the coast of Berwickshire the Silurian rocks are highly contorted, and so also are the rocks near the Old Head of Kinsale, in Ireland.

When the English Channel is crossed the rock foldings are found to be on a still greater scale in surface extension than is indicated by the observation of British rocks alone. Along the whole distance, from Westphalia on the east to Somersetshire on the west, and even further, to South Wales, the Palæozoic rocks are folded in a succession of synclinals and anticlinals; and in the Ardennes, forming part of this line, enormous masses of these folded rocks have been removed by denudation, yet hills approaching mountains in elevation are left which are the remnants of the original vast plications. In the Eifel district of Germany the Devonian rocks are greatly plicated, and of the same age are the rocks forming a great anticlinal in the Department of the Sarthe, in France; while Silurian rocks show foldings on an extensive scale in Bohemia.

Those who have travelled by the railway from Macon to Geneva may remember the rock foldings displayed by the cuttings along the base of the Jura range of mountains. These foldings of the Secondary rocks in the Jura are, or have been, regularly alternating synclinals and anticlinals, though now showing much denudation, which in many cases has transformed the synclinal folds into elevations and the anticlinals into depressions. But when the Alps themselves are reached, rock folding is on a truly stupendous scale. Even to the ordinary tourist, the precipitous side of the Rhigi towards Lake Lucerne shows, by the inclined beds there conspicuously displayed, the enormous uptilting and folding to which the Alpine rocks have been subjected; and at the southern end of the same lake, near Fluelen, highly plicated rocks will arrest his attention. It is, however, by the perforation of the main axis of the Alps by the great tunnel of the St. Gothard that we have become acquainted with rock folding in perhaps its greatest manifestation. Thus it has been found that the rocks forming the central portions of this great mountain range are mainly the vertical portions of vast plications, and at Andermatt and Airolo these rocks rise

in a fan-shaped manner which gives actual inversions of strata. This enormous folding is found to be the prevailing character of the Alpine rocks from the northern side of Switzerland to the plains of Lombardy. The summit of the Great Ruchen, ten thousand feet above sea-level, affords another example of a former vast fold having left as its witness a remnant of vertical beds; and on both sides of the great mass of Mont Blanc, in the Val de Chamouni and the Val Ferret, are vertical Jurassic rocks which are but the remains of a fold that has extended over the rocks forming the summit of the monarch of the Alps. A grand example of inversion of strata is seen in the Glarnish Alp, where the beds are folded, as has been said, even as we might fold carpets. In the extreme north of Europe, too, both in Norway and the Ural Mountains, the Palæozoic rocks are found to be folded on a most extensive scale, giving in some places quite vertical strata, though overlaid by horizontal beds of recent geological age.

As in Europe so in Asia, the mountainous regions exhibit flexures on a grand scale, with Palæozoic rocks that are but the remnants of vast folds, in some of which, as in Baltistan in the Himalayan region, the plications have been sufficiently extreme to quite reverse the original sequence of the beds. Far to the south of the Himalayas, too, in Mysore, the rocks have been greatly folded, and so far denuded as to leave but remnants of their original plications. In Asia, however, not only are the Palæozoic and the Secondary rocks folded on a great scale, but Tertiary strata are so too. The Eocene rocks of Afghanistan and Beluchistan give the broken and denuded anticlinal valley of Chumarlong, and the anticlinals at Tungar and the Deka ridge. Again, to the east, the great folds of the Tertiary rocks form anticlinals on both sides of the River Jhelum, with synclinals so elevated as to give peaks and ridges forming lofty mountains, as the Murree Ridge; while Mount Mianjani, on the west of the great vale of Kashmeer, nearly ten thousand feet, is also formed by folded Tertiary rocks. The great Eocene Limestone, called the Nummulitic Limestone, is in great flexures in the north-west of India, which rise in the Balket Mountains to six thousand feet above sea-level, and in the Sievalik Hills the still newer Sandstones are greatly folded.

Though the mountainous regions of Africa have not yet been sufficiently explored to afford geological details, and many of the highlands are volcanic, yet we have abundant evidence of great folding of the rocks in that continent also, both in the north and the south. As was shown in KNOWLEDGE, page 51 of the present volume, the auriferous rocks of the Transvaal Witwatersrand are highly inclined, and are but remaining portions of great folds. In the north of Africa, and forming a large part of the main range of the Great Atlas, are grey Shales having a nearly vertical position. Of these rocks Mr. George Maw says they are pre-Cretaceous, and "their almost vertical position appears connected with one of the several upheavals that have affected the chain." Metamorphic rocks, having a dip of from fifty degrees to eighty degrees, form hills in the immediate neighbourhood of the city of Morocco.

The great western continent of America tells the same tale of enormous rock foldings. Although in North America there are great areas formed of rocks but little folded, yet in Canada, near the eastern coast, Palæozoic rocks, conformably overlying the Laurentian, have been much folded and even contorted; and in the neighbourhood of Lake Superior there is a natural arch of rocks formed by an anticlinal, the interior rocks having been removed by water erosion. In Colorado both the Palæozoic and the Secondary rocks are so upheaved as to be almost vertical, being parts of great folds, and in the Mosquito range there are reversed folds. In Texas there are synclinal troughs, the bases of once enormous folds; and in New Mexico the Carboniferous rocks are quite vertical, and in places even folded on themselves.

The rocks of the more eastern parts of the United States are also greatly folded. Indeed, so enormous has the plication been in the Appalachian Mountains, that Prof. Claypole estimates the compression of the original horizontal extension of the Appalachian rocks by subsequent folding to have been from one hundred and fifty-three miles to a present breadth of sixty-five miles. In Virginia and South Carolina the rocks are greatly folded, and in Massachusetts and Vermont the same phenomenon is conspicuous, vertical strata being displayed in the former of these two States.

In South America there is a magnificent display of folded and uptilted rocks, the Silurians, nearly vertical, rising to about twenty-five thousand feet above sea-level at the summit of the Andes; and the Devonians and Carboniferous rocks forming great folds or parts of folds, chiefly synclinals, at lower levels, the latter giving to the west of Lake Titicaca a wonderful series of upturned edges. The Peruvians and Secondaries of the Andes exhibit similar phenomena.

Nor is rock folding on a great scale wanting in the Australasian continent. In the Ballarat district of Victoria the Lower Silurian rocks have been so greatly folded that the strata are often nearly vertical; while in Gipps Land, in the same colony, the Devonian rocks are highly inclined, and in the Cape Otway district there is an enormous anticlinal fold of Mesozoic rocks.

Many other remarkable illustrations of rock folding might be given; but those now cited will suffice to conclusively show that the rocks forming the outer rind of the earth's lithosphere have been subjected at various times and at various places to enormous lateral pressure, that has folded, plicated, and crumpled them previous to the production of the present surface features. The discussion of the cause of this pressure must be left for a future occasion.

WAVES.—VII.

THE ARTISTIC STUDY OF WAVES.

By VAUGHAN CORNISH, M.Sc.

A GOOD sea-piece always makes a pleasing picture, and the foundation of a good sea-piece is correct drawing of the water, showing the form and indicating the motion of the waves. Instantaneous photography reproduces with absolute fidelity the form of the water surface as it would appear to the eye if illuminated, say at night, by a lightning flash. Such an instantaneous illumination makes moving objects appear at rest, and this is apt to be the effect of photographs of the sea. When watching the waves under ordinary conditions, the sense of movement is probably due, in part at least, to the persistence of impressions upon the retina, several impressions received at successive moments being simultaneously present. To reproduce this effect in a picture the phases represented together upon the canvas should be nearly but not quite simultaneous.

I propose to examine a number of sea-pieces which are to be seen in the London galleries at the present time, in order to show how the artists have rendered the forms of waves. Taking the National Gallery first, which contains some excellent examples of the old Dutch sea painters, I find in Van der Welde's picture, "A Gale" (No. 876), a good representation of short rough waves quickly raised by a

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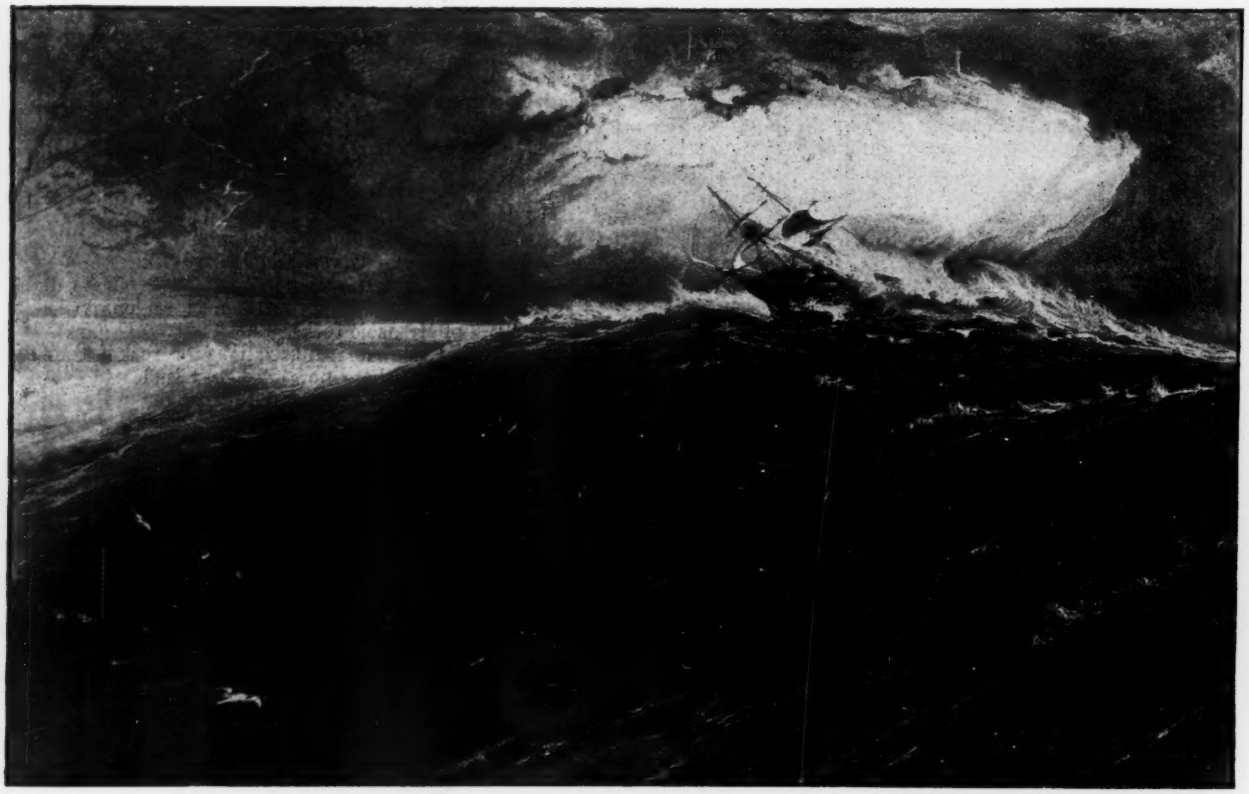
brisk wind in shallow sea. The profile of several successive waves, concave on the lee, and curving over, perhaps *a little* too much, on the weather side, should be noticed. The same aspect is shown in some of Bakhuizen's pictures, but not so well.

In the Turner Gallery are many famous sea-pieces. He likes to perch a boat precariously upon an isolated mound of water. This may be a way of indicating the toss and tumble of the sea, but the balanced rhythm of the undulation is thereby lost. "The Shipwreck" (No. 476) is an instance of this, in which there is a great heap of water on the right-hand side, and nothing to balance it on the left. However, such is the aspect of sea waves which Turner chooses to represent, and one would bow to genius and pass on if these great unbalanced billows were at all like the waves of the sea, but they are not. The fluid has more the consistency of tar—it is some slow viscous fluid tossed into great heaps. Take, for instance, No. 813: "Boats in a Stiff Breeze off the Coast." The height of the waves is nearly half the length from crest to crest; and in "Spithead" (No. 481) the slope of the waves is about forty-five degrees. The wind has raised the waves, but gravity has no power to bring them down again and the breeze has no force to drive them forward. On the other hand, the wild sea towards the horizon in the picture of "Calais Pier" (No. 472) is very fine; but it is generally the waves in the background which are Turner's best. His breakers (in No. 496) are as bad as his deep-sea waves. If anyone doubt his eyes when looking at these pictures, deeming his visual memory too unreliable to justify him in finding fault with a master's work, let him go straight from the Turner Gallery to the Chantrey pictures and the Prescot Hewett Gift pictures at South Kensington, and test his impressions by examining some of the finest wave pictures in the world. On students' days at the National Gallery one cannot but regret to see so many artists copying sea-pieces in which the sea is badly drawn, when really good studies of waves are to be found so near at hand.

There are some half-dozen wave paintings at South Kensington which at once bring the real thing before one. Perhaps, as a study of waves, the best of all is "A Grey Day at Sea," by Sir Francis Powell (No. 421 in the Prescot Hewett Gift). In this picture I note the following points of careful observation accurately rendered, most of which are missed even in the average of good sea-pieces. The waves run from right to left before a strong wind, and in the foreground on the left we see the back or weather slope of the first of a train of waves. This slope is much less steep than that of the lee side of the next on-coming wave. It is driven by the onward rush of the wind, instead of being supported and heaped up by the wind eddy, as are the leeward slopes. Again, on the weather slope the rushing wind tears at the water, raising new waves upon the slope of the billow. In another moment the top of the wave will break and the pressure of the wind will be relieved. The lee slope of the next on-coming wave is in comparative calm, sheltered in the eddying wind; but the surface of the steep slope, though smooth, is covered with a thin network of transparent foam; and here the artist has shown great power of observation. The foam was left when the



An Indiaman in a North-Wester off the Cape of Good Hope. From a picture by Mr. Wm. Daniell, R.A.

preceding wave passed this point. The crest of the wave broke, streams of water-drops flew out, streaking the back of the wave and giving it a "ropy" look. This is not actually shown, for it happened a second or two before the time represented in the picture, but the painting is so good that we can reason backwards from it. This ropy appearance is seen on a small scale at a certain stage in the splash of a falling drop, and is shown in a drawing in Mr. Worthington's admirable papers on that beautiful phenomenon. The streaking of the back of the wave indicates the presence of little ridges and furrows, which (as well, perhaps, as the larger ridges and furrows due to cross waves) give rise to a vast number of whirlpools on the back of the breaking wave. The foam of the breaking crest, left behind as the wave rushes on, is whirled round in the vortices. The vortices are always formed in pairs, each pair consisting of a right-handed and a left-handed whirl. The foam is collected round the edges of the whirls, and particularly where the whirls approach one another, and a thin transparent network (for the bubbles have burst, leaving only a thin film) is formed, the meshes of the net being oval, for the circles are drawn out into ovals by the forward motion of the water. This, I think, is how the floating film of foam assumes the characteristic and wonderfully persistent form which is so well indicated in Sir Francis Powell's picture.* Again, there is a tendency to form a *knife edge* along the crest of all billows (whether of water *or of sand*) which are forced at their crest by the co-operation of a forward current and a backward eddy, as is the case with the storm waves of the sea and with ripple-mark in sand. The knife edge is shown on the billows to the right hand of the picture in exactly the proper way, for the artist has shown the sharp edge without falling into the mistake of making the top of the wave too thin. In a more distant part of the same billow we see the spraying "white horses," just where the crests of the cross waves give to the main billow a height too great for its forward velocity; and the upward as well as forward motion of the spray is just indicated. In fact, a mass of detailed observation has been accurately embodied, and perhaps condensed, in this small picture, and the result is far finer than that of any attempted emphasis by way of exaggeration. When I look at this picture I see the storm itself; and soon, as each true detail starts out clear before me, I feel the stinging spray and breathe the rasping air.

"Where the wild Atlantic surges Rush with headlong race to shore."

From the water-colour painting by Mr. Reginald Smith, in the Royal Academy Exhibition of 1896. (By kind permission of the Artist.)

Among the larger works in the adjoining rooms, "Britannia's Realm," by Mr. John Brett, shows a great stretch of blue sea covered with the little waves raised by a light zephyr. The scale of the picture is a part of its merit, for it is only by including a multitude of waves upon the canvas that an artist can fully convey the rhythmical effect of a repeating undulation. Mr. Vicat Cole's "Pool of London," which is placed next to this picture, gives a fine rendering of the restless waters of a tidal river where wind conflicts with current. "Their Only Harvest," by Mr. Colin Hunter, in the next room, brings out well the cross waves which generally traverse the larger undulations of the sea. The rendering of this effect, emphasized by a low light, is characteristic of this artist's pictures. Mr. G. H. Andrews' water-colour drawing, "A Storm in the North Sea," takes in only two of the great storm billows; but the flanks of these are themselves carved into waves of a not inconsiderable size. The effect of a squall, with

* There is another point to be noticed about the effect of vortex motion upon the appearance of water: it gives a stretched or oily look to the surface; probably, as has been suggested to me, because the surface is renewed from below too rapidly for ripples to form. This stretched look is often noticeable on the back of the breaker, especially in a ground swell, and it deserves the attention of sea painters. The most familiar example of the appearance produced by vortices is the swirling wake behind a rudder. Another example is the wake left outside the edges of the paddles of a steamer. A sharp edge introduced in running water will generally give it. The effect may often be noticed also in a swirling river.

driving rain, upon the surface of the water, is excellently done.* The picture is a genuine study of a storm at sea, which is, of course, much more rarely painted than the storm waves as seen from land. The late Mr. William Daniell is one of the few painters who has represented from personal experience the storm waves of the open ocean. Fig. 1 is a reproduction of his picture, "An Indiaman in a North-Wester off the Cape of Good Hope," reproduced from a fine print in the British Museum. The immense velocity of these very long waves is finely indicated in the billow which rushes from right to left, having just raised the ship to its summit. This artist was too much given to exaggeration to be quite satisfactory as a sea painter: his waves are often ridiculously steep besides being too high; but this picture has the merit of conveying an impression of the great length and speed of ocean waves.

The Academy of 1896 has a large number of sea-pieces of varying degrees of merit. Perhaps the best study of waves is No. 1161 in the Water-Colour Room, by Mr. Reginald Smith: "Where the wild Atlantic surges rush with headlong race to shore," which is reproduced from a photograph in Fig. 2. We are looking towards the coast, and see the sloping rounded backs of the rollers, whose long undulating crests extend far to the right, rank upon rank charging irresistibly along. In this picture the network film of foam is very well rendered. In the left lower corner only does the drawing fall below excellence. In Mr. John Fraser's picture, "Newhaven" (405), in No. V. Gallery, the heaving of the waves near a vertical wall has been skilfully preserved, while all trace of forward motion has been properly suppressed. In Mr. J. C. Hook's pictures (Nos. 48 and 279) the water is so smooth as to give little scope for wave drawing on the scale adopted; yet a careful examination shows great mastery of the forms and motion of the sea. Mr. Wm. J. Callcott has put plenty of movement into the sea in "Smeaton's Lighthouse on the Eddystone" (No. 411), but he makes the common mistake of representing, in the foreground of the picture, two waves which are back to back, running away from one another instead of following in procession. Mr. C. Napier Hemy's "Through Air and Sea, through Scud and Spray," is one of the best wave studies. The light coming through the top of the wave on the left indicates the thinness at the crest, which, from its position, could not be shown by the drawing. The action in the picture seems to cease abruptly in the right-hand corner, which is a pity. In "Volunteers for a Boat's Crew" (917), by Mr. T. Somerscales, there is wild white water lit by sunshine in the distance, and a sluggish sea under a black cloud in the foreground. The effect of contrast is fine, but I think the drawing has been to some extent sacrificed for the sake of this effect; there seems too much wind in the picture for the nearer waves to move so sluggishly. There are a number of sea-pieces in this year's Academy which I cannot criticize because they have no drawing, and this applies to several pictures by distinguished sea painters, who have not taken the trouble to draw the forms they know so well. For complete disregard of drawing in sea-pieces, however, the most notable collection of examples I have seen is in this year's Paris exhibitions.

For good book illustrations of waves I may refer to Mr. Robert Leslie's charming "Waterbiography." All his illustrations of the sea are worth studying. Mr. Leslie knows the sea too well either to slur over the drawing, or to attempt an increased effect by exaggerating the forms of waves.

Of wave phenomena, other than the wind-raised waves of the sea, artists take but little note. I have met with hardly any attempt to represent a train of standing waves in a rapid stream, except in one picture in the Luxemburg Gallery, and that is not successful. Ship waves are sometimes done, the earliest attempt that I am acquainted with being in Turner's well-known picture, "The Fighting Téméraire towed to her Last Berth." In a fine picture now at Versailles, "Arrivée de l'Escadre Russe, Toulon, 13 Octobre, 1893," by M. Paul Jobert, the curved and stepped front of the echelon ship-waves is well shown.

Photographic views of waves consist for the most part of studies of big breakers on rocky coasts, with clouds of flying spray, and, sometimes, masses of curdled foam. Mr. Worsley Benison's "Westby Series" of photographs are the finest studies with which I am acquainted. One of these is reproduced in our full-page illustration. There is no sea painter, however skilful, who would not find much to repay him in the careful study of such photographs. Above all, the foam is rendered as no painter ever rendered it: not merely the thin film of foam of which I have already spoken, but the thick white froth of the breaker line, which looks by daylight like whipped cream, but by moonlight is changed to molten silver. This difference of aspect, I think, is due to the circumstance that in moonlight we only get a surface, and therefore a metallic, reflection; whereas the sun's stronger rays pierce into the curdled masses and then struggle up again into the air, thus imparting the translucence which gives to foam its look of lightness.

* The following explanation has been given of the smoothing of the sea by rain. The rain does not penetrate, but, driving water down before it, mixes up parts of the sea water the momentum of whose oscillation is in opposite directions, thus annulling the rhythmic swing of wave motion.

THE FACE OF THE SKY FOR JULY.

By HERBERT SADLER, F.R.A.S.

THE Sun's disc is now comparatively free from spots. Conveniently observable minima of Algol occur at 0h. 5m. A.M. on the **5th**; at 8h. 54m. P.M. on the **7th**; and at 10h. 36m. P.M. on the **27th**.

Mercury is visible as a morning star during the first three weeks of the month. He rises on the **1st** at 2h. 44m. A.M., or 1h. 6m. before the Sun, with a northern declination of 19° 44′, and an apparent diameter of $8\frac{1}{4}''$, about $\frac{3}{10}$ths of the disc being illuminated. On the **4th** he rises at 2h. 30m. A.M., with a northern declination of 20° 28′, and an apparent diameter of 7·6″, being at his greatest western elongation (21¼°) at noon. On the **8th** he rises at 2h. 34m. A.M., or 2h. 20m. before the Sun, with a northern declination of 21° 30′, and an apparent diameter of 7″, about one-half of the disc being illuminated. On the **11th** he rises at 2h. 35m. A.M., or 1h. 24m. before the Sun, with a northern declination of 22° 11′, and an apparent diameter of $6\frac{1}{2}''$, about $\frac{6}{10}$ths of the disc being illuminated. On the **16th** he rises at 2h. 45m. A.M., or 1h. 20m. before the Sun, with a northern declination of 22° 54′, and an apparent diameter of $5\frac{3}{4}''$, about three-quarters of the disc being illuminated. On the **21st** he rises at 3h. 7m. A.M., or 1h. 2m. before the Sun, with a northern declination of 22° 46′, and an apparent diameter of $5\frac{1}{8}''$, $\frac{87}{100}$ths of the disc being illuminated. After this he approaches the Sun too closely to be conveniently observed. While visible, Mercury passes through the eastern portion of Taurus into Gemini, being near η Geminorum on the evening of the **11th**, and μ Geminorum on the evenings of the **12th** and **13th**. He is at his

BREAKERS ON A ROCKY COAST,

Showing the thin film of foam and the thick white curdled froth of the breaker line.

greatest western elongation (21¼°) on the **4th**, and in superior conjunction with the Sun on the **31st**.

Venus is in superior conjunction with the Sun on the **9th**, and Mars is, for the observer's purposes, invisible.

Jupiter is now too near the Sun for satisfactory observation.

Saturn is an evening star, setting on the **1st** at 1h. A.M., with a southern declination of 13½°, and an apparent equatorial diameter of 16¾″ (the major axis of the ring system being 41″ in diameter, and the minor 14⅓″). On the **9th** he sets at 0h. 28m. A.M., with a southern declination of 13° 20′, and an apparent equatorial diameter of 16½″. On the **18th** he sets at 11h. 49m. P.M., with a southern declination of 13° 22′, and an apparent equatorial diameter of 16½″ (the major axis of the ring system being 40¼″ in diameter, and the minor 14″). On the **22nd** he sets at 11h. 34m. P.M., with a southern declination of 13° 23′, and an apparent equatorial diameter of 16½″. On the **29th** he sets at 11h. 6m. P.M., with a southern declination of 13° 27′, and an apparent equatorial diameter of 18¼″ (the major axis of the ring system being 39½″ in diameter, and the minor 13¾″).

Iapetus is in inferior conjunction on the **1st**, and at his greatest western elongation at 9h. 30m. P.M. on the **21st**. He is almost stationary in Libra throughout the month.

Uranus is an evening star, but owing to his great southern declination is not well situated for observation. On the **1st** he rises at 4h. 2m. P.M., with a southern declination of 17° 41′, and an apparent diameter of 3·8″. On the **30th** he sets at 11h. 2m. P.M., with a southern declination of 17° 37′. He is almost stationary in Libra throughout the month.

Neptune does not rise till after midnight at the end of the month.

Shooting stars are fairly numerous in July, but twilight interferes with observation. There is a well-marked shower near δ Aquarii towards the end of the month, the maximum being on the **28th**. The radiant point is in R.A. 22h. 40m., south declination 13°.

The Moon enters her last quarter at 1h. 23m. A.M. on the **3rd**; is new at 7h. 35m. P.M. on the **10th**; enters her first quarter at 4h. 4m. P.M. on the **17th**; and is full at 5h. 45m. P.M. on the **24th**. She is in apogee at 3h. A.M. on the **3rd** (distance from the Earth, 251,150 miles); in perigee at 6h. P.M. on the **15th** (distance from the Earth, 229,200 miles); and in apogee at 10h. P.M. on the **30th** (distance from the Earth, 251,280 miles).

Chess Column.

By C. D. Locock, B.A.Oxon.

Communications for this column should be addressed to C. D. Locock, Burwash, Sussex, and posted on or before the 10th of each month.

Solution of June Problem.

(A. G. Fellows.)

1. Kt to B6, and mates next move.

Correct Solutions received from Alpha, J. M. K. Lupton, G. A. F. (Brentwood), Arthur S. Coulter, A. C. Challenger, W. Willby, W. V. Popham, H. H. Quilter, H. S. Brandreth, and J. T. W. Claridge.

Correct Solutions of May Problems, received too late for acknowledgment last month, from J. M. K. Lupton and E. W. Brook.

F. Welch.—1. Kt to K4, Kt×Kt, 2. P to B4 mate, and other variations; 2. Kt to B6 mate is threatened.

G. G. Beazley.—If 1. Kt to Q2, Q×B, and there is no mate.

H. Le Jeune.—Is Kt to B5 a misprint for Kt to B6?

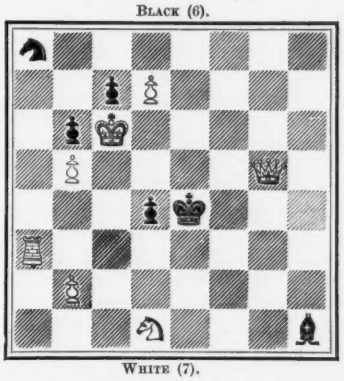
A. C. Challenger.—Many thanks. Your compositions are always welcome.

W. J. Ashdown.—Thanks for your interesting communication printed below.

PROBLEM.

By A. C. Challenger.

BLACK (6).



WHITE (7).

White *compels Black* to mate in two moves.

Mr. W. J. Ashdown has sent the following interesting communication on

THE EIGHT QUEENS PROBLEM.

The Queens Problem on a board of sixteen squares has two solutions, namely (using the German notation), A2, B4, C1, D3, and A3, B1, C4, D2. Let diagrams of these two positions be placed one overlapping the other to the extent of six squares—that is, with the top left-hand square of the A3 diagram resting on B2 square of the A2 diagram, being a Knight's move downwards. The three Queens must be removed where overlapping occurs, and this is a rule to be observed throughout.

The position now obtained may be placed on an extended board, the Queens occupying squares B6, C8, D3, E7, F4, and within a rectangle of thirty squares. This rectangle with its five Queens may be called the "initial position," as all the solutions of the Eight Queens Problem are derived from it. Let the board be extended indefinitely upwards and to the right, and a second "initial position" placed upon it, with the corners of the rectangle resting on squares F10, F5, J10, J5, being two Knights' moves to the right. The two rectangles will then overlap four squares, and the Queen thereon must be removed. The four added Queens are at G10, H5, I9, J6. This may be called the "doubled position."

The Queen's stride being limited to seven squares on the ordinary board, the eighth square in any direction is "out of range," and additional Queens can, therefore, be placed at A1, D11, G2. This at once gives seven solutions of the problem. Thus, the sixty-four squares, from B9, B2, to I9, I2, contain the solution α, and the others are:—

Sixty-four squares from	A8 to H1	contain solution	β.
,,	,,	C9 to J2	,,	γ.
,,	,,	B10 to I3	,,	δ.
,,	,,	C11 to J4	,,	ζ.
,,	,,	B11 to I4	,,	ι.
,,	,,	C10 to J3	,,	λ.

Any arrangement whatever of Queens, where all are

kept out of each other's range, will possess this property, namely, that every set of x^2 squares within it that includes x Queens will be a solution of the x Queens problem—where x equals the number of squares in the side of the board—but "out of range" will vary according to the length $(x-1)$ of the Queen's stride.

Take solution α, and remove the right-hand "initial position," and notice what squares are available for Queens in substitution for those thus removed. The only other vacancies are at H9 and I5, and two Queens there will give solution θ.

Similarly, solution ζ—the left-hand "initial position" being removed (restoring the missing Queen at F8)—with substitutions at C7 and E4, will give solution η.

At first sight there would appear to be no connection between the symmetrical solution shown on page 24 and the above. But let one of the "doubled positions" be superimposed on another, and one of them rotated half-way round (through 180°), using the meeting point of D5 and E4 as centre of rotation. The rule as to omitting all Queens where overlapping now occurs must be observed, and the symmetrical solution ω will be at once obtained, being the central part of this position. The reason for the symmetry is thus ascertained. It is a little curious that if a board of twenty-five squares, with its unsymmetrical solution (A3, B5, C2, D4, E1), be treated in this way, the turning point being easily seen, the solution ω for a board of sixty-four squares will be arrived at.

Take this position ω (page 24, second column) as a fresh starting position, and transfer it two squares to the right. This will throw two Queens off the board, but the one on the fifth rank comes on again at A5. The other, in being brought on to the third rank at H3, pushes H1 to B1 (the only available square), and the solution κ is obtained.

Let this solution κ be another starting position, and transfer it three squares upwards and one to the left. This will throw four Queens off the board, but the two now on the C and F files produced will at once come on again at C1 and F2. The two others, which should come on again at D3 and H8, find both those squares "covered," and have to be satisfied with D8 and H3. This gives the remaining solution ε.

The last five solutions read thus on the ordinary board:—

θ	...	A5, B7, C2, D6, E8, F1, G8, H4.
η	...	A4, B8, C1, D5, E7, F2, G6, H3.
ω	...	A4, B6, C8, D2, E7, F1, G3, H5.
κ	...	A5, B1, C4, D6, E8, F2, G7, H3.
ε	...	A4, B7, C1, D8, E5, F2, G6, H3.

The twelve absolutely distinct positions admit of rotation, bringing each of the four sides in turn to the top, and giving forty-eight changes. There are two repetitions arising from the symmetrical position, and the number is reduced to forty-six. All these can be turned over from right to left, making a total of ninety-two. The number of distinct ways of actually arranging the Queens so as to solve the problem *on the board* is twenty-four, and no one of these positions can be changed to any other without moving the Queens to other squares. But from the twenty-four positions the remainder of the ninety-two can be obtained by simply turning the board and Queens *en bloc*.

The application of the above principles to boards of other dimensions might produce some interesting results.

Mr. Ashdown sends also an ingenious automatic diagram for producing positions on a forty-nine-square board. The height of the diagram is seven squares, but the board is unlimited in its extension towards the right. Placing Queens on A7, B3, and H7, and taking these squares as starting points, lines of Queens are constructed sloping *downwards towards the right*, each Queen being the distance of a Knight's move from its neighbours on the same line. Thus, the first position is A7, B3, C6, D2, E5, F1, G4. Now omit the A file and substitute the H file, and a fresh position is obtained. This process, which is available whenever the height of the board is $(6a + 3 \pm 2)$ squares—*i.e.*, for boards of five, seven, eleven, thirteen, etc., squares—may be continued until the positions repeat themselves.

CHESS INTELLIGENCE.

Mr. E. O. Jones has again won the Challenge Cup of the Craigside, Llandudno, meeting.

The Nuremberg International Tournament is fixed for July 20th. It will conclude on August 6th. The prizes are very valuable, and all the leading players except Dr. Tarrasch are expected to compete.

A match of one hundred players a side, representing the north and south sides of the Thames, took place on May 9th, at the Cannon Street Hotel. The northern representatives were victorious by $57\frac{1}{2}$ to $42\frac{1}{2}$.

On May 15th a team of eight players of the City of London Club, by no means their best team, succeeded in drawing a match against the newly-established Divan Association. The merit of the performance will be apparent from the fact that the latter team consisted of E. Lasker, I. Gunsberg, R. Teichmann, J. Mason, L. Van Vliet, S. Tinsley, A. Guest, and R. F. Fenton.

Entries for the *Brighton Society* Two-move Self-mate Tourney should reach the Chess Editor, 101, Queen's Road, Dalston, N.E., before November 1st. Three prizes are offered, and the adjudication will be by experts.

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NOTICES.

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